MICROTECH

ENERGY 400 -PRELIMINARY-

technical user manual

electronic controller for Chiller/Heat pump up to 4 steps

invensys

1 SUMMARY

2 HOW TO USE THIS MANUAL

This manual is designed to permit quick, easy reference with the following features:

References

References column**:**
A column to the left of the text contains *references* to subjects discussed in the text to help you locate the information you need quickly and easily.

Cross references

Cross references:
All words written in *italics* are referenced in the subject index to help you find the page containing details on this subject; supposing you read the following text:
"when the alarm is triggered, the *compressors* will be shut down"
The italics mean that you will find a reference to the page on the topic of *compressors* listed under the item *compressors* in the index.
If you are consulting the manual "on-line" (using a computer), words which appear in italics are hyperlinks: just click on a word in italics with the mouse to go directly to the part of the manual that discusses this topic.

Icons for emphasis:

Some segments of text are marked by icons appearing in the *references* column with the meanings specified below:

Take note: information on the topic under discussion which the user ought to keep in mind

Tip: a recommendation which may help the user to understand and make use of the information supplied on the topic under discussion.

Warning! : **information which is essential for preventing negative consequences for the system or a hazard to personnel, instruments, data, etc., and which users MUST read with care.**

3 INTRODUCTION

Energy 400 is a compact device that permits control of air conditioning units of the following types:
- air-air
- air-water
- water-water
- motor-condensing

The controller can manage machines with up to four *power steps* distributed in a maximum of 2 *cooling* circuits (for example, 2 circuits, with 2 *compressors* per circuit).

Main characteristics:
- Outflowing water temperature control
- Condensation control
- 2 inputs which may be configured for NTC or 4-20mA (through *parameters*)
- 11 configurable *digital inputs* + (4 four optional)
- *Dynamic set point*
- Setting of *parameters* from the *keyboard*, with a personal computer or with a interface module
- *Remote keyboard* (100 m) which may be connected up directly without serial interfaces.
- 3 4-20 mA *outputs*
- Control of 1, 2, 3, or 4 *compressors*.

3.1 Components

We will now look at the basic *components* and accessories in the system and how they are connected.

3.1.1 Energy 400

The basic module is an electronic card for connection with I/O resources and a CPU as described in the section on *connection diagrams*.

3.1.2 Extension

The basic module is an electronic card for connection as described in the section on *connection diagrams*.

3.1.3 Keyboards

Two types of *keyboard* are available:
- **TS-P:** Panel *keyboard* (32x74)
- **TS-W:** *Wall-mounted keyboard*

3.1.4 CF (Control Fan) Modules

Used to connect fans with *Energy 400 low voltage outputs*.

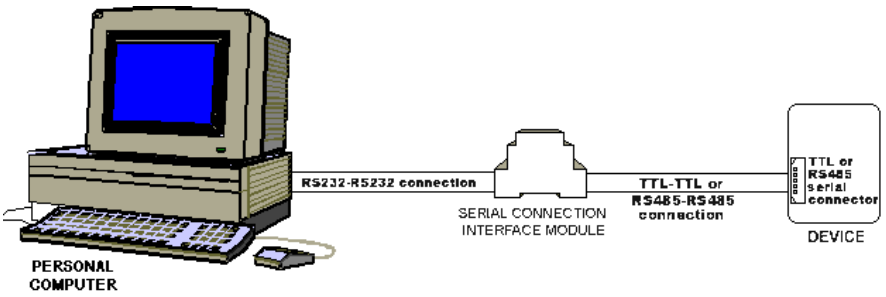
3.1.5 Copy Card

Can be used to upload and download the *Energy 400* parameter map.

3.1.6 Serial Interface (EWTK)

A device which permits the controller to interface with a Personal Computer

It must be connected up as illustrated in the figure



The PC must be connected with the interface module, and the interface module with the device, with no power on to any of the devices, and in compliance with current safety regulations **. Be careful to avoid electrostatic shocks, especially on exposed metal parts of the devices; allow electrostatic shocks to discharge into the ground before handling.**

3.1.7 Param Manager

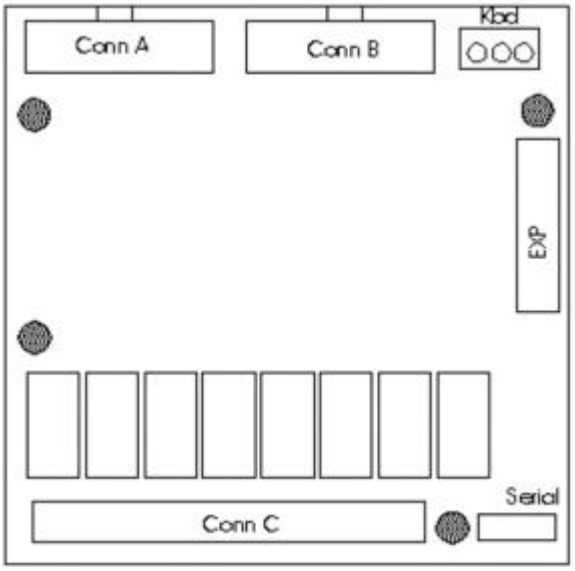
If you have an adequate Personal Computer with Windows 95 or a more recent operating system, the *Param Manager* software, an adequate interface module and proper wiring, you can have full control over all *Energy 400 parameters* via Personal Computer.
The instrument can be programmed easily and quickly using a series of interfaces which permit a logical, guided approach.

4 INSTALLATION

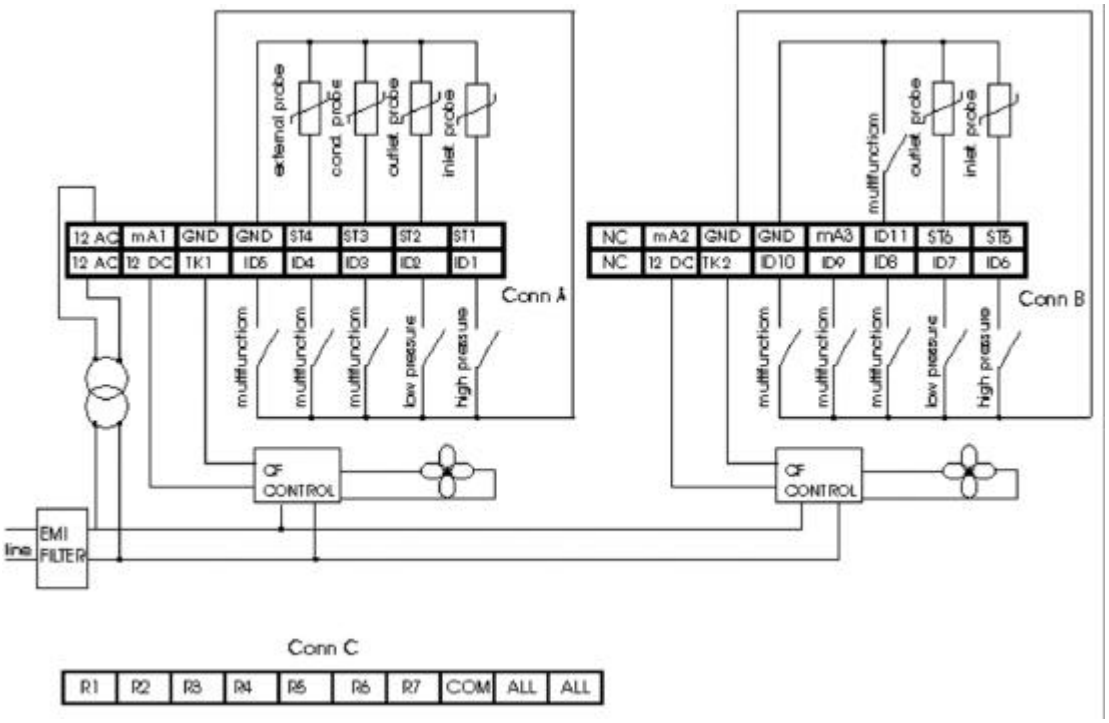
Before proceeding with any operation, first make sure that you have connected up the power supply to the device through an appropriate external current trransformer**.**
Always follow these rules when connecting boards to one another and to the application:
Never apply *loads* **which exceed the limits set forth in these specifications to** *outputs***;**
Always comply with *connection diagrams* **when connecting up** *loads***;**
To prevent electrical couplings, always wire low voltage *loads* **separately from high voltage** *loads***;**

4.1 Connection diagrams

Basic module



Detail of connectors



Instrument configuration is determined by the values of the *parameters* associated with inputs and *outputs*.

4.2 Configuration of analogue inputs

Analogue inputs

There are 6 *analogue inputs*:

- 4 NTC transducers,
- 2 configurable NTC/4-20mA transducers.

The following devices shall henceforth be referred to by the codes ST1....ST4:
ST1 – Temperature control probe: inflowing water or air, reading *range* : -30°C ÷ 90°C;
ST2 – Configurable probe, reading *range*: -30°C ÷ 90°C;
ST3 - Configurable NTC probe, 4-20mA
ST4 - Configurable probe, reading *range* : -30°C ÷ 90°C;
ST5 - Configurable NTC probe, 4-20mA
ST6 - Configurable probe, reading *range*: -30°C ÷ 90°C;

Analogue inputs: resolution and precision

4 *analogue inputs* are available on the *extension* which is not used in this release.
The resolution of NTC *analogue inputs* is one tenth of a Kelvin degree;
They are precise to within 0.8°C within the *range* of 0÷35°C and to within 0.8°C ÷ 3°C in the remainder of the scale.
The 4-20mA input is precise to within 1% FS, with a resolution of one tenth of a Kelvin degree, if the input is configured as a *dynamic set point*, or Kpa*10 if the input is configured as a pressure probe.

Analogue inputs: configuration table

ST1-ST6 probes can be configured according to the following table:

Pa.	Description	Value					
		0	1	2	3	4	5
H11	Configuration of analogue input ST1	Probe absent	NTC input inflowing water or air	Digital input request for *heating*	Digital input request for temperature control	Differential NTC input	Not permitted
H12	Configuration of analogue input ST2	Probe absent	NTC input outflowing water/air, anti-freeze	Digital input request for *cooling*	Not permitted	Not permitted	Not permitted
H13	Configuration of analogue input ST3	Probe absent	NTC input condensation	4...20 mA condensation input	4...20 mA input for *dynamic set point*	NTC antifreeze for water-water gas reversal machines	NTC *heating* control for water-water water reversal machines
H14	Configuration of analogue input ST4	Probe absent	NTC input condensation	Multifunctional digital input	NTC input for outdoor temperature	Not permitted	Not permitted
H15	Configuration of analogue input ST5	Probe absent	NTC input outflowing water/air	Not permitted	Not permitted	Not permitted	Not permitted
H16	Configuration of analogue input ST6	Probe absent	NTC input condensation circuit 2	4-20mA input condensation	Not permitted	Antifreeze input for water-water gas reversal machines	Not permitted

If inputs ST3 and ST6 are defined as 4-20mA inputs under pressure, the scale bottom value of the pressure input is also significant:
Pa H17 **=** Maximum input value; set the corresponding value to a current of 20 mA

4.3 Configuration of digital inputs

Digital inputs

There are 11 voltage-free *digital inputs*, which will henceforth be identified as ID1....ID11.
ST1, ST2, and ST4 may be added to these if they are configured as *digital inputs* (through *parameters Pa H11*, *Pa H12*, *Pa H14*). 4 more *digital inputs* are available on the *extension*.

Digital inputs: polarity

The polarity of *digital inputs* is determined by the *parameters* listed below:
ID1, ID2, ID3, ID4 defined by parameter *Pa H18*,
ID5, ID6, ID7, ID8 defined by parameter *Pa H19*
ID9, ID10, ID11, ST4 (if configured as digital) defined by parameter *Pa H20*
ID12,ID13,ID14,ID15 on *extension* defined by parameter Pa N01

Digital inputs: Polarity table

Pa H18	**ID1**	**ID2**	**ID3**	**ID4**
Pa H19	**ID5**	**ID6**	**ID7**	**ID8**
Pa H20	**ID9**	**ID10**	**ID11**	**ST4**
Pa H21	**ID12**	**ID13**	**ID14**	**ID15**
0	Closed	Closed	Closed	Closed
1	Open	Closed	Closed	Closed
2	Closed	Open	Closed	Closed
3	Open	Open	Closed	Closed
4	Closed	Closed	Open	Closed
5	Open	Closed	Open	Closed
6	Closed	Open	Open	Closed
7	Open	Open	Open	Closed
8	Closed	Closed	Closed	Open
9	Open	Closed	Closed	Open
10	Closed	Open	Closed	Open
11	Open	Open	Closed	Open
12	Closed	Closed	Open	Open
13	Open	Closed	Open	Open
14	Closed	Open	Open	Open
15	Open	Open	Open	Open

Example: A value of “10” for parameter *Pa H18* indicates that *digital inputs* ID1 and ID3 are active when their contacts are closed and *digital inputs* ID2 and ID4 are active when their contacts are open:

Pa H18	**ID1**	**ID2**	**ID3**	**ID4**
10	Closed	Open	Closed	Open

If ST1 is configured as digital, its polarity is defined by parameter *Pa H21*
If ST2 is configured as digital, its polarity is defined by parameter Pa H22

Parameter Value	**Description**
0	Active if closed
1	Active if open

All *digital inputs* are configurable and may be given the meanings listed below by setting *parameters Pa H23* through *Pa H34* and Pa N02 through Pa N05

Digital inputs: Configuration Table

Parameter Value	**Description**
0	Input disabled
1	Flow switch
2	Remote OFF
3	Remote Heat/Cool
4	Thermal switch compressor 1
5	Thermal switch compressor 2
6	Thermal switch compressor 3
7	Thermal switch compressor 4
8	Thermal switch fan circuit 1
9	Thermal switch fan circuit 2
10	High pressure circuit 1
11	High pressure circuit 2
12	Low pressure circuit 1
13	Low pressure circuit 2
14	High pressure compressor 1
15	High pressure compressor 2
16	High pressure compressor 3
17	High pressure compressor 4
18	End of *defrost* circuit 1
19	End of *defrost* circuit 2

In the case of multiple inputs configured with the same value, the function associated with the input will carry out a Logical OR among the inputs.

Outputs

4.4 Configuration of outputs

There are two basic types of *outputs*: *power outputs*, and *low voltage outputs*.

4.4.1 Power outputs

There are 8 *power outputs*, which shall henceforth be referred to as RL1...RL8 (relays).
RL1 - compressor 1, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL2 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL3 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL4 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL5 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL6 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL7 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL8 – cumulative alarm, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;

There are 2 additional digital *outputs* in the *extension* module:
RL9 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;
RL10 - configurable, 5 A 125VAC/230VAC Res; ¼ HP 230VAC, 1/8 HP 125VAC;

Configurable *outputs* may be given the following meanings by setting *parameters Pa H35* through *Pa H40* and Pa N06 through Pa N07

Configuration table

Value	**Description**
0	Disabled
1	Reversal valve circuit 1
2	Reversal valve circuit 2
3	Condenser fan circuit 1
4	Condenser fan circuit 2
5	Electrical heater 1
6	Electrical heater 2
7	Pump
8	Evaporator fan
9	*Power Step* 2
10	*Power Step* 3
11	*Power Step* 4

Polarity of RL2,RL3,RL4,RL5,RL8 may be selected using *Pa H41-Pa H45*

Polarity Table

Parameter Value	**Description**
0	Relay closed if output active
1	Relay open if output not active

If multiple *outputs* are configured with the same resource, the *outputs* will be activated in parallel.

4.4.2 Low voltage outputs

There are a total of 4 *low voltage outputs* available: 2 phase cut *outputs* and 2 4-20 mA *outputs*:
TK1 – Output for piloting external fan control modules in circuit 1.
TK2 – Output for piloting external fan control modules in circuit 2.
AN1 - 4-20mA output for control of fans in circuit 1
AN2 - 4-20mA output for control of fans in circuit 2

Outputs AN1 and AN2, though their connections are physically separate, are alternatives to *outputs* TK1 and TK2 which are selected by *parameters Pa H45* and *Pa H46*

Configuration of fan outputs

Fan config. parameter	**Index**	**Value 0**	**Value 1**
Fan 1 output	H45	Fan 1 output in phase cut	Fan 1 output in 4-20 mA
Fan 2 output	H46	Fan 2 output in phase cut	Fan 2 output in 4-20 mA

4.4.3 Serial outputs

There are 2 asynchronous serials on the control:
- channel for serial communication with a personal computer through a Microtech interface module
- channel for serial communication with a standard Microtech *keyboard*. Power supply 12 VDC (2400,e,8,1).

4.5 Physical quantities and units of measurement

Parameter *Pa H64* may be used to set temperature *display* in either degrees °C or degrees °F:

Unit of measurement: selection

Pa H64	**Unit of measurement**
0	Degrees °C
1	Degrees °F

5 USER INTERFACE

The interface on the front panel of the instrument can be used to carry out all the operations connected to the use of the instrument, and in particular to:

- Set operating mode
- Respond to alarm situations
- Check the state of resources

Keyboard

Front panel of the instrument

The instrument can function without the aid of a *keyboard*

5.1 Keys

Mode

Selects operating mode:

If the *heating* mode is enabled, each time the key is pressed the following sequence occurs:
Stand-by → *cooling* → *heating* → *stand-by*

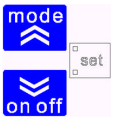
if *heating* mode is not enabled:
Stand-by → *cooling* → *stand-by*

In menu mode, this key acts as a *SCROLL UP* or UP key (increasing value).

Resets *alarms*, and turns the instrument on and off.

Press once to *reset* all manually *reset alarms* not currently active; all the *alarm events per hour* will also be *reset* even if the *alarms* are not active.
Hold down the key for 2 seconds to turn the instrument from on to off or vice versa. When it is off, only the decimal point remains on the *display*. In menu mode this key acts as a *SCROLL DOWN* or DOWN key (decreasing value).

Pressing the "mode" and "on-off" *keys* at the same time:



If you press both *keys* at the same time and then release within 2 seconds, you will move one level deeper in the *display* menu.
If you press both *keys* for more than 2 seconds you will move one level up.
If you are currently viewing the lowest level in the menu and you press both *keys* and release within 2 seconds, you will go up one level.

5.2 Display

The device can communicate information of all kinds on its status, configuration, and *alarms* through a *display* and a number of leds on its front panel.

5.2.1 Display

Normal *display* shows:

- regulation temperature in tenths of degrees celsius or fahrenheit
- the alarm code, if at least one alarm is active. If multiple *alarms* are active, the one with greater priority will be displayed, according to the Table of *Alarms*.
- If temperature control is not analogue and depends on the status of a digital input (ST1 or ST2 configured as *digital inputs*), the "On" or "Off" label will be displayed, depending on whenther temperature control is active or not.
- When in menu mode, the *display* depends on the current position; labels and codes are used to help the user identify the current function.

5.2.2 Led

Led 1 compressore 1.
ON if compressor 1 is active

- OFF if compressor 1 if off
- Rapid *BLINK* if *safety timing* is in progress
- Slow *BLINK* if compressor is currently set to *defrost*

Power step 2 *led*
ON if *power step* 2 is active

- OFF if *power step* 2 is not active
- Rapid *BLINK* if *safety timing* is in progress
- Slow *BLINK* if step 2 is currently defrosting

Led step 3 di potenza
ON se lo step 3 di potenza è attivo
- OFF se lo step 3 di potenza non è attivo
- *BLINK* veloce se sono in corso temporizzazioni di sicurezza
- *BLINK* lento se step 3 in sbrinamento

Power step 4 *led*
- ON if *power step* 4 is active
- OFF if *power step* 4 is not active
- Rapid *BLINK* if *safety timing* is in progress
- Slow *BLINK* if step 4 is defrosting

Electrical heater/boiler *led*
- ON if at least one internal anti-freeze electrical heater or boiler is enabled
- OFF if both are off

Heating Led
- ON if the device is in *heating* mode.

Cooling Led
- ON if the controller is in *cooling* mode

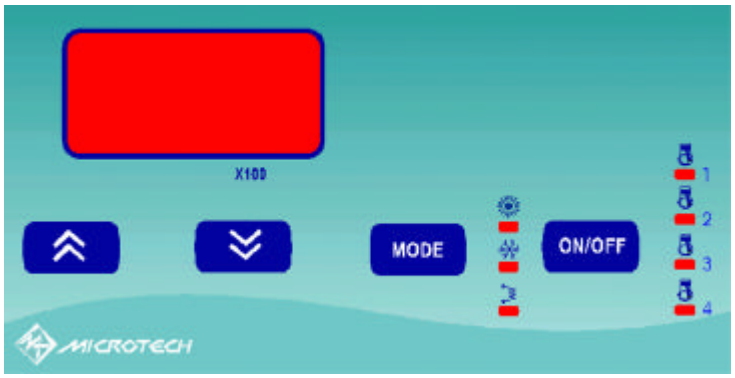
If neither the *HEATING led* nor the *COOLING led* are in, the controller is in *STAND-BY* mode.
When it is off, only the decimal point appears on the *display*.

5.3 Wall-mounted keyboard

Remote keyboard

The *remote keyboard* a on the *display* is an exact copy of the information displayed on the instrument, with the same leds;

Remote keyboard

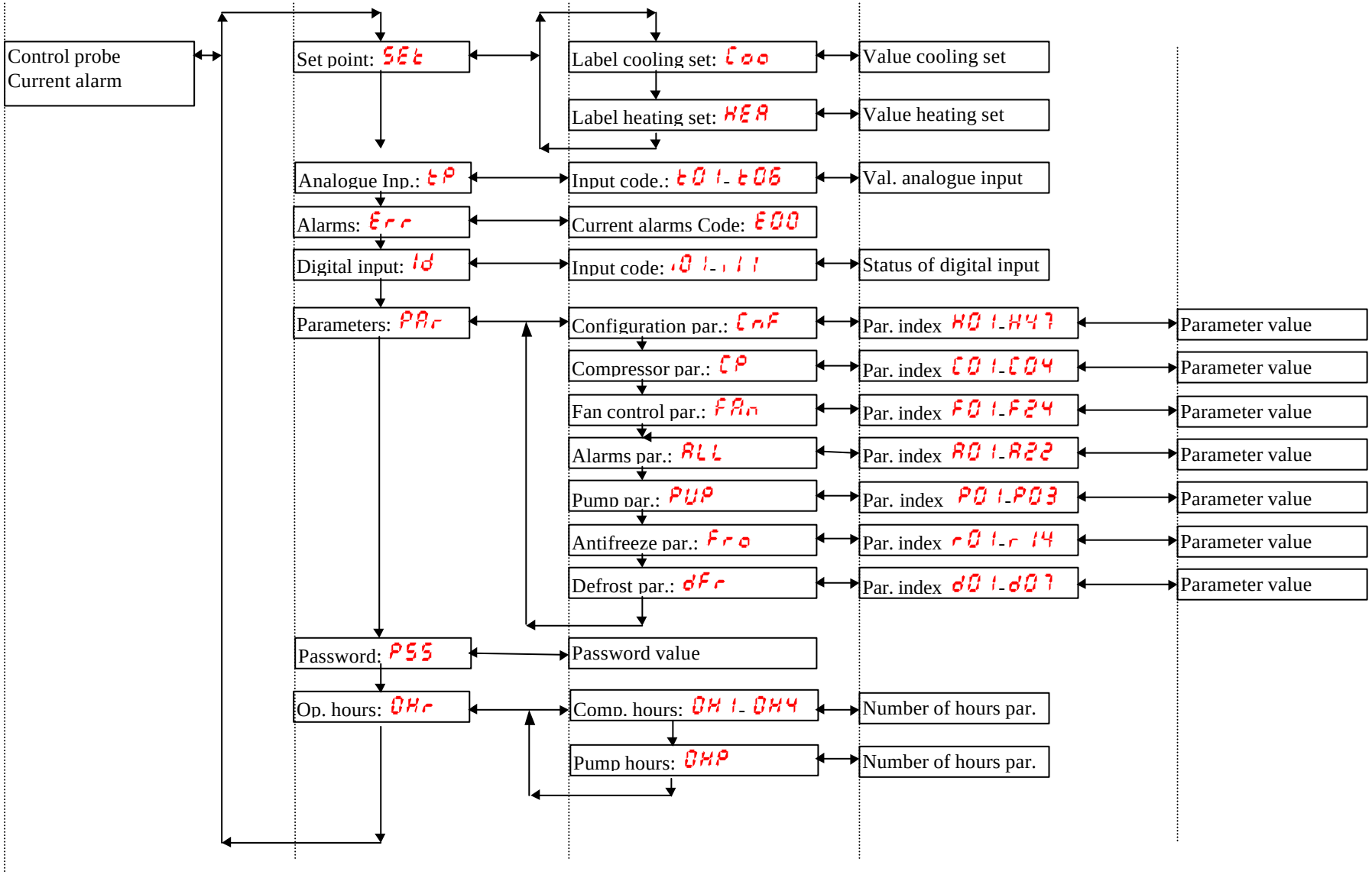


It performs exactly the same *functions* as those described in the *display* section.
The only difference is in use of the UP and DOWN *keys* (to increase and decrease value), which are separate from the MODE and ON/OFF *keys*.

5.4 Programming parameters – Menu levels

Device *parameters* may be modified using a Personal Computer (with the required software, interface key and cables), or using the *keyboard*;
If using the *keyboard*, access to *parameters* is arranged in a hierarchy of levels which may be accessed by pressing the "mode and "on-off" *keys* at the same time (as described above).
Each menu level is identified by a mnemonic code which appears on the *display*.
The structure is set up as shown in the diagram below:

Menu structure



5.5 Visibility of parameters and submenus

With a personal computer, interface key, suitable cables and the "*Param Manager*" software, it is possible to restrict the visibility and modification of *parameters* and entire submenus.
A "visibility value" may be assigned to each parameter, as described below:

Value	Meaning
0003	Parameter or label visible at all times
0258	Parameter or label visible if user password entered correctly (password = *Pa H46*)
0770	Parameter or label visible if user password entered correctly (password = *Pa H46*). Parameter cannot be modified.
0768	Parameter visible from PC only.

Some visibility settings are factory set.
For more information, please refer to the "*Param Manager*" instructions.

5.5.1 Copy Card

The *copy card* can store the whole map of *Energy 400 parameters*;
To download the map present in the *copy card*, proceed as follows:
1. Connect the key to the appropriate *Energy 400* output (refer to *connection diagrams*) while the device is off.
2. Turn on the *Energy 400*: the *parameters* map in the *copy card* will be copied to the *Energy 400*.

To store the *Energy 400 parameters* map in memory, proceed as follows:
1. Connect the *copy card* to the appropriate *Energy 400* output (refer to *connection diagrams*) while the device is on.
2. From the *keyboard*, access the "password" submenu (refer to *menu structure*) and set the value contained in parameter *Pa H46*: The instrument's map will be downloaded to the *copy card*.
3. Disconnect the *copy card* when finished.

6 SYSTEM CONFIGURATION

In this section we will look at how to configure *parameters* for various *loads* on the basis of the type of *installation* to be controlled.

6.1 Compressors

Energy 400 can control systems consisting of up to two *cooling* circuits with 1 to 4 *compressors*.
If there is a capacity step, it will be considered as a compressor.
Each compressor is piloted by a device relay (*power outputs*) (each capacity step requires an additional output).
The first compressor must be connected to output RL1; the remaining *outputs* (RL2...RL7) (RL9...RL10 on *extension*) may be assigned at will, setting the value of the *parameters Pa H35* .... PaH40 (Pa N06 ... Pa N07 if there is no *extension*).
The *compressors* will be turned on or off depending on the temperatures detected and the *temperature control functions* that have been set (refer to the section on Compressor controls – Regulation algorithml)

6.2 Compressor configuration

Power step

The turning on of an additional compressor (or capacity step) will henceforth be referred to as a *Power step* (power level).

The following configurations are available for *compressors* without capacity steps:

Simple compressors

		Number of *compressors* per circuit			
		1 (*Pa H06*=1)	**2 (*Pa H06*=2)**	**3 (*Pa H06*=3)**	**4 (*Pa H06*=4)**
Number of circuits	**1 (*Pa H05*=1)**	RL1=comp. 1 circ.1	RL1=comp. 1 circ. 1 Step2 = comp 2 circ.1	RL1=comp. 1 circ. 1 Step2 = comp 2 circ.1 Step3 = comp 3 circ.1	RL1=comp. 1 circ. 1 Step2 = comp 2 circ.1 Step3 = comp 3 circ.1 Step4 = comp 4 circ.1
	2 (*Pa H05*=2)	RL1=Comp. 1 circ.1 Step3 = comp. 1 circ.2	RL1=comp. 1 circ. 1 Step2 = comp 2 circ.1 Step3 = comp 1 circ.2 Step4 = comp 2 circ.2	Configuration error	Configuration error

with 1 capacity step

The following configurations are available for *compressors* with 1 capacity step (*Pa H07*=1):

		Number of *compressors* per circuit	
		1 (*Pa H06*=1)	**2 (*Pa H06*=2)**
Number of circuits	**1 (*Pa H05*=1)**	RL1=comp. 1 circ. 1 Step2 = cap. step1 Comp.1 circ.1	RL1=comp. 1 circ. 1 Step2 = cap. step1 Comp.1 circ.1 Step3 = comp.2 circ.1 Step4 = cap. step1 Comp.2 circ.1
	2 (*Pa H05*=2)	RL1=comp. 1 circ. 1 Step2 = cap. step1 comp.1 circ.1 Step3 = comp.1 circ.2 Step4 = cap. step1 comp.1 circ.2	Configuration error

with 2 or 3 capacity steps

The following configurations are available for *compressors* with 2 or 3 capacity steps (*Pa H07*=2 or *Pa H07*=3):

		Number of *compressors* per circuit	
		1 (*Pa H06*=1 and *Pa H07*=2)	**2 (*Pa H06*=2 and *Pa H07*=3)**
Numbero of circuits	**1 (*Pa H05*=1)**	RL1=comp. 1 circ. 1 Step2 = cap. step1 comp.1 circ.1 Step4 = cap. step2 comp.1 circ.1	RL1=comp. 1 circ. 1 Step2 = cap. step1 comp.1 circ.1 Step3 = cap. step2 comp.1 circ.1 Step4 = cap. step3 comp.1 circ.1
	2 (*pa H05*=2)	Configuration error	Configuration error

6.2.1 Compressor (or power step) on/off sequences

Depending on the temperature conditions detected by the probes, the *temperature control functions* of the "*Energy 400*" may request turning on and off of *compressors*/capacity steps (*power steps*).
The sequence in which *compressors*/capacity steps (steps) are turned on and off may be determined by adjusting the values of *parameters Pa H08* and *Pa H09* as described below:

		Parameter value	
Par	Description	0	1
Pa H08	*Power step* on sequence	Depends on number of hours of operation	Unvaried on sequence
Pa H09	Circuit balacing	Circuit saturation	Circuit balancing

When on sequences depend on the number of hours of operation, of 2 available *compressors*, the one which has been operated for less hours will come on first, and the one which has been operated for more hours will always go off first. In an unvaried on sequence, the compressor with the lower number will always come on first (compressor 1 before compressor 2) and the compressor with the higher number will always go off first.

The circuit balancing parameter is significant only if there are 2 circuits and 2 steps per circuit. If we select H09=0, all *power step*s in one circuit will come on before those in the other circuit. If H09=1 (balancing), *power step*s will come on in such a way that both circuits are delivering the same power, or the difference is no more than one step.

Let us take a closer look at the various combinations:

Compressors: coming on on the basis of hours of operation and circuit saturation

Pa H08=**0** *Pa H09*=**0**

CASE OF 1 COMPRESSOR WITH CAPACITY STEP PER CIRCUIT:	CASE OF 2 *COMPRESSORS* PER CIRCUIT:
The compressor with the least hours of operation comes on first, then the capacity step for the same circuit, the compressor on the other circuit, and, lastly, its capacity step. When turning off, the capacity step of the compressor with the most hours of operation goes off first, then the corresponding compressor, then the other capacity step and finally the other compressor. Example: Supposing the system has been configured as follows: **RL1=Compressor 1 circuit 1** **Step2 = capacity step compressor 2** **Step3 = compressor 2 circuit 2** **Step4 = capacity step compressor 2** If **hours comp.1 > hours comp.2** they will come on in this order **Step3→Step4→RL1→Step2** and go off in this order **Step2→RL1→Step4→Step3**	If all *compressors* are off to start with, the circuit which has the lower *average number of hours* for all its *compressors* will come on first. In this circuit the compressor with the least hours of operation will come on first, followed by the other compressor in the same circuit: thus the circuit is saturated. The next step is chosen between the two *compressors* in the other circuit with fewer hours. Example: Supposing the system has been configured as follows: **RL1=Compressor 1 circuit 1** **Step2 = compressor 2 circuit 1** **Step3 = compressor 3 circuit 2** **Step4 = compressor 4 circuit 2** If **hours comp.1 > hours comp.2** **hours comp.4 > hours comp.3** **(hours comp.1 + hours comp.2)/2>(hours comp.4 + hours comp.3)/2** they will come on in this order **Step3→Step4→Step2→RL1** and go off in this order **RL1→Step2→Step4→Step3**

Compressors: coming on on the basis of hours of operation and circuit balancing

Pa H08=**0 and** *Pa H09*=**1**

CASE OF 1 COMPRESSOR WITH CAPACITY STEP PER CIRCUIT:	CASE OF 2 *COMPRESSORS* PER CIRCUIT
The compressor with the least hours of operation comes on first, followed by the compressor in the other circuit, the capacity step of the first circuit to come on, and, lastly, the other capacity step. When going off, the capacity step of the compressor with the most hours goes off first, followed by the capacity step of the other compressor, the compressor with the most hours and, lastly, the remaining compressor. Example: Supposing the system has been configured as follows: **RL1=Compressor 1 circuit 1** **Step2 = capacity step compressor 2** **Step3 = compressor 2 circuit 2** **Step4 = capacity step compressor 2** if **hours comp.1 > hours comp.2** they will come on in this order **Step3→RL1→Step4→Step2** and go off in this order **Step2→Step4→RL1→Step3**	If all *compressors* are off to start with, the circuit with the lower *average number of hours* for its *compressors* will come on first. The average is calculated as the ratio between the total number of hours of the *compressors* available and the number of *compressors* in the circuit. In this circuit, the compressor with the least hours will come on first, then the compressor in the other circuit with the least hours, the other compressor in the first circuit and, lastly, the remaining compressor. Example: Supposing the system has been configured as follows **RL1=Compressor 1 circuit 1** **Step2 = compressor 2 circuit 1** **Step3 = compressor 3 circuit 2** **Step4 = compressor 4 circuit 2** if **hours comp.1 > hours comp.2** **hours comp.4 > hours comp.3** **(hours comp.1 + hours comp.2)/2>(hours comp.4 + hours comp.3)/2** they will come on in this order **Step3→Step2→Step4→RL1** and go off in this order **RL1→Step4→Step2→Step3**

Compressors: unvaried on sequence with circuit saturation

Pa H08=**1 and** *Pa H09*=**0**

CASE OF 1 COMPRESSOR WITH CAPACITY STEP PER CIRCUIT	CASE OF 2 *COMPRESSORS* PER CIRCUIT
The compressor con with the lower number comes on first, then its capacity step, then the compressor in the other circuit and, lastly, its capacity step. The capacity step for the compressor with the highest number is the first to go off, followed by the capacity step of the other compressor, and finally the compressor. Example: Supposing the system has been configured as follows: **RL1=Compressor 1 circuit 1** **Step2 = capacity step compressor 2** **Step3 = compressor 2 circuit 2** **Step4 = capacity step compressor 2** they will come on in this order **RL1→Step2→Step3→Step4** and go off in this order **Step4→Step3→Step2→RL1**	Exactly the same as the first case.

Compressors: unvaried on sequence with circuit balancing

Pa H08=**1 e** *Pa H09*=**1**

CASE OF 1 COMPRESSOR WITH CAPACITY STEP PER CIRCUIT	CASE OF 2 *COMPRESSORS* PER CIRCUIT
The compressor with the lowest number comes on first, then the compressor in the other circuit, the capacity step of the first compressor and then the capacity step of the second compressor. They go off in reverse order. Example: Supposing the system has been configured as follows: **RL1=Compressor 1 circuit 1** **Step2 = capacity step compressor 2** **Step3 = compressor 2 circuit 2** **Step4 = capacity step compressor 2** they will come on in this order **RL1→Step3→Step2→Step4** and go off in this order **Step4→Step2→Step3→RL1**	Exactly the same as the first case.

In the unvaried sequence, if the compressor with the lower number is unavailable, the compressor with the higher number comes on.
If the compressor comes available and the amount of power required is equal to the amount of power being delivered, the machine will continue to function in its current state: it will not turn off a compressor with a higher number to turn on a compressor with a lower number.

A compressor is unavailable when it is shut down due to an alarm or is currently counting *safety timing***.**

6.2.2 Compressor timing

Safety timing

The turning on and off of *compressors* must comply with safety times which may be set by the user using the *parameters* specified below:

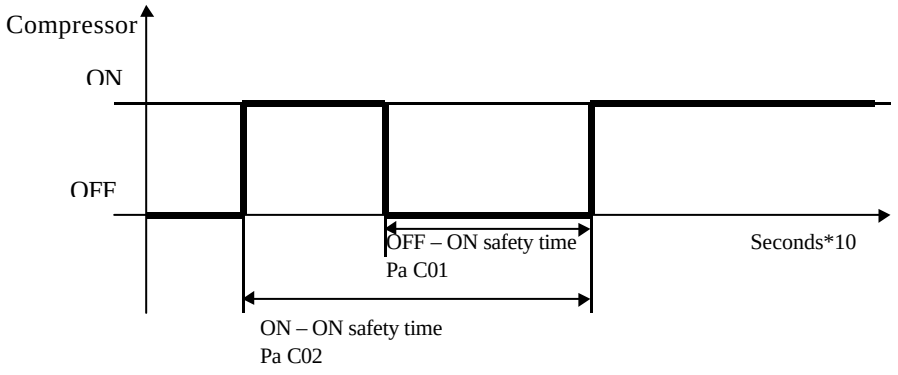
Off-on timing

There is a safety interval between the time a compressor goes off and the time the same compressor comes back on (compressor on...off safety time, controlled by parameter *Pa C01*);
This interval of time must elapse when the "*Energy 400*" is turned on.

On-on timing

There is a safety interval between the time a compressor is turned on and the time it is turned on again (compressor on...on safety time, controlled by parameter *Pa C02*) .

Off-on and on-on diagram for 1 compressor

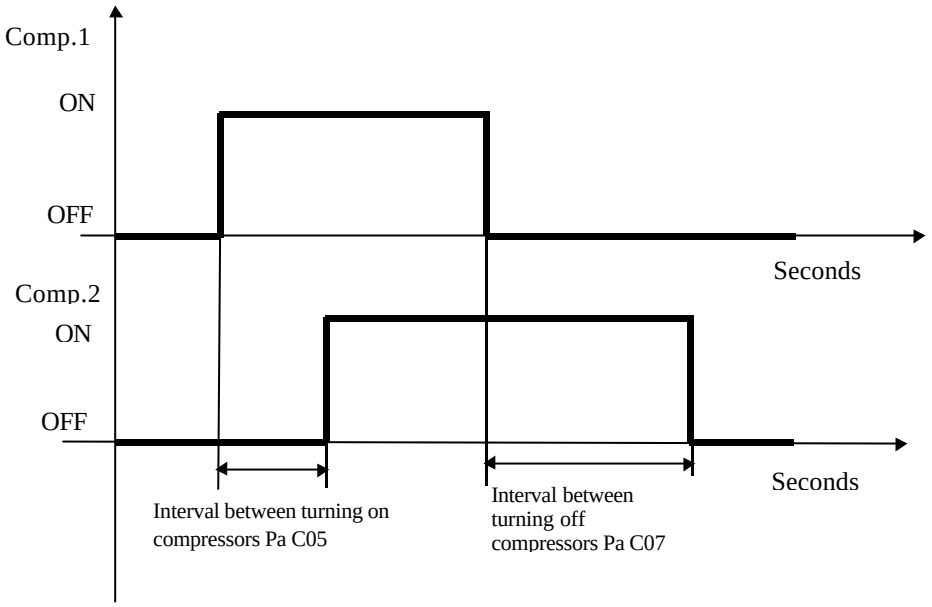


On-on off-off times for 2 comp.

If the machine has multiple *power steps*, there are intervals of time which must pass between turning on of 2 *compressors* (*Pa C06*) and turning off of 2 *compressors* (*Pa C07*). An amount of time determined by parameter *Pa C08* (capacity step on delay) must elapse between the turning on of one compressor or capacity step and the turning on of any other

compressor or capacity step on the machine. The greatest of the currently active safety times must be applied to each compressor.
The off time interval between *compressors* is not applied in the event of a **compressor shutdown alarm,** in which case they stop immediately.

on-on and off-off diagram 2 comp



6.3 Condensation fan

"*Energy 400*" may be connected with two types of fan piloting unit:

- Triak
- 4-20 mA

6.3.1 Fan configuration

First of all, correctly configure the type of analogue output (*low voltage outputs*) to which the fan control module(s) are connected;
the relevant *parameters* are *Pa H45* for the first circuit and *Pa H46* for the second circuit, as shown in the table below:

Parameter value	**Circuit 1 –** *Pa H45*	**Circuit 2 –** *Pa H46*
0	TK output enabled for phase cut	TK output enabled for phase cut
1	Enable 4-20 mA output AN1	Enable 4-20 mA output AN2

If the output is configured as a proportional triac, the *parameters PICK-UP*, *PHASE SHIFT*, and *IMPULSE DURATION* are also significant.

Pick-up

Every time the external fan is started up, power is supplied to the exchanger fan at maximum voltage, and the fan operates at maximum speed, for an amount of time equal to *Pa F02* seconds; after this time the fan operates at the speed set by the regulator.
Pa F02 = Fan *pick-up* time (seconds)

Phase shift

Determines a delay during which it is possible to compensate the different electrical characteristics of the fan drive motors:
Pa F03 **=** duration of fan *phase shift* expressed as a percentage.

Impulse duration

Determines the duration of the TK output piloting impulse in microseconds*10
*Pa F04***=** triak piloting *impulse duration*

6.3.2 Fan control configuration

The fan control may be configured to supply a proportionate output (0-100%) or to function as "ON OFF" by setting the value of the parameter *Pa F01*:

Pa F01 **=** *Selection* of control output type

Fan configuration: selection of output type

Pa F01 = 0	proportionate fan output (from 0 to 100% depending on *parameters*)
Pa F01 = 1	fan "on-off" output; in this mode the control performs the same calculations as in proportionate output, but if the outcome is greater than 0, the control output will be 100.
Pa F01 = 2	on-off operation as called by compressor. In this mode output is 0 if no compressor is on in the circuit, or 100% if at least one compressor in the circuit is on

If some of the relays are configured as *condensation fan outputs* (*Pa H35- Pa H40* and Pa N06- Pa N07=3 or 4), they will be on if the control output for each fan is greater than 0; otherwise, they will be off.

6.4 Reversing valves

Reversing valve

The *reversing valve* is used only when operating in "heat pump" mode.
"*Energy 400*" can control up to 2 *reversing valves* in a dual circuit system.

The *reversing valve* in circuit 1 is active only if:
- a relay (power output) is configured as *reversing valve* for circuit 1 (*Pa H35-Pa H40* or Pa N06 and Pa N07= 1).

The *reversing valve* in circuit 2 is active only if:
- a relay (power output) is configured as *reversing valve* for circuit 2 (*Pa H35-Pa H40* or Pa N06 and Pa N07= 2)
- there are 2 circuits

Both of them will be active only if
the heat pump is in operation (Pa H10=1)

6.5 Hydraulic pump

The *hydraulic pump* is active only if at least one relay (power output) is configured as pump output (*Pa H35-Pa H40* or Pa N06-Pa N07= 7) .

The pump may be configured to function independently of the compressor or whenever called up using parameter *Pa P01*:

Pa P01 = Pump operating mode
0=continuous operation
1=operation when called up by regulation algorithm

with a flow switch alarm (table of *alarms*) which is active with automatic *reset*, the pump will be on even if the compressis off.

6.6 Anti-freeze/supplementary electrical heaters

"*Energy 400*" can control up to 2 *anti-freeze/supplementary electrical heaters*.

The electrical heater output is active only if the relays (*power outputs*) are configured as electrical heaters 1 or 2 (*Pa H35-Pa H40* or Pa N06-Pa N07= 5 or 6) .
If configured in this way, the *outputs* will command the electrical heater to come on or go off, depending on the *parameters* of configuration of electrical heaters *Pa R01* ... *Pa R06*, as described below:

configuration

Parameter	Description	Value	
		0	1
Pa R01	*Defrost* configuration	comes on only when requested by control	always on during *defrost*
Pa R02	*Cooling* mode configuration	off during *cooling*	on during *cooling* (depending on anti-freeze electrical heater control)
Pa R03	*Heating* mode configuration	off during *heating*	on during *heating* (depending on anti-freeze electrical heater control)
Pa R06	OFF or *STAND-BY* configuration	off when OFF or on *STAND-BY*	Electrical heaters on when OFF or on *STAND-BY*

Parameters r04 and r05 determine which probe the electrical heaters will control.
Each of the two electrical heaters may be set to any one of probes ST1, ST2 or ST5.
If the is absent or configured as a digital input, the electrical heaters will always be off.

Pa r04 configuration probe set to electrical heater 1
Pa r05 configuration probe set to electrical heater 2

probe configuration

Value *Parameters*	Description
0	Electrical heater off
1	Set to ST1
2	Set to ST2
3	Set to ST5

6.7 Internal fan

The fan output will be active only if one relay is configured as evaporator fan output.
The output is ON if at least one compressor is ON; otherwise it is off. During *defrost* the output is always off.

6.8 Condensation-Defrost probes

"*Energy 400*" can control defrosting of one or more circuits depending on *system configuration*.

Defrost is enabled if:
- stated by the "Enable *defrost*" parameter (*Pa d01* = 1)

- the condensation probe for circuit 1 is present (connected to analogue input ST3) and the relative parameter *Pa H13* = 1 (in the case of an NTC probe) or *Pa H13* = 2 (in the case of a 4-20mA probe) and ST4 = 1
- the *reversing valve* is present

In the case of a dual circuit system, *defrost* may be separate or combined (this will be the case of a system with a single condenser) depending on the setting of the parameter
Pa F22 : condensation type

separate or combined condensation

	0	1
Pa F22: **condensation type**	Separate condensers	Combined condensation

Defrost end and start depends on the values of the condensation probes, which may be configured as follows:

Let SCC1 be the condensation probe of circuit 1; it may be connected to analogue input ST3 or ST4;
depending on the type of probe, the configuration will be as shown in the table below:

probe configuration

	Probe connection	
Probe type	**Probe connected to ST3**	**Probe connected to ST4**
SCC1 NTC type	*Pa H13* = 1	*Pa H14* = 1
SCC1 4-20mA type	*Pa H13* = 2	-

The following table applies to a dual circuit system:

	1 circuit	**2 circuits, separate** *defrost*	**2 circuits, combined** *defrost* **(*)**
Defrost circuit 1	SCC1	SCC1	MIN(SCC1;ST6)
Defrost circuit 2	---	ST6	MIN(SCC1;ST6)

(*) If A and B are control probes, MIN(A;B) represents
the smaller of A and B, if A and B are declared present.
It will be value A if B is not declared present.
It is impossible for A not to be declared present.

7 TEMPERATURE CONTROL FUNCTIONS

Once "*Energy 400*" has been configured, *loads* may be controlled on the basis of temperature and pressure conditions detected by probes and *temperature control functions* which may be defined using the appropriate *parameters*.

Operating modes

There are 4 possible *operating modes*:
- *cooling*
- *heating*
- *stand-by*
- off

Cooling

Cooling: this is the "summer" operating mode; the machine is configured for *cooling*.

Heating

Heating: this is the "winter" operating mode; the machine is configured for *heating*.

Stand-by

Stand-by: the machine does not govern any temperature control function; it continues to signal *alarms*

Device off

Off: machine is turned off.

The operating mode is determined by settings entered on the *keyboard* and by the following

Parameters:
Configuration parameter ST1 (Pa H11) (refer to *Analogue inputs: configuration table*)
Configuration parameter ST2 (Pa H12) (refer to *Analogue inputs: configuration table*)
Operating mode *selection* parameter (Pa H49)
Heat pump parameter (Pa H10)

Operating mode *selection* parameter (Pa H49)
0= *Selection* from *keyboard*
1= *Selection* from digital input (refer to *digital inputs*)

Heat pump parameter (Pa H10)
0 = Heat pump not present
1 = Heat pump present

Operating modes: configuration table

Combinations of these *parameters* will generate the following rules:

Operating mode	Mode *selection* parameter *Pa H49*	Configuration parameter ST1 *Pa H11*	Configuration parameter ST2 *Pa H12*
Mode *selection* from *keyboard*	0	Other than 2	Other than 2
Mode *selection* from digital input.	1	Other than 2	Other than 2
If input ST1 is on, operating mode is *heating*; if not, *stand-by*	Any	2	Other than 2
If input ST2 is on, operating mode is *cooling*; if not, *stand-by*	Any	Other than 2	2
If input ST1 is on, operating mode is *heating*; if input ST2 is on, operating mode is *cooling*; if ST1 and ST2 are both on, there is a control error; if neither is on, operating mode is *stand-by*	Any	2	2

7.1 Setting set points

Unless the machine is configured as a motor condenser, *loads* will come on and go off dynamically depending on the *temperature control functions* set, the temperature/pressure values detected by the probes, and the *set point*s that have been set:

There are two *set point* values:
Cooling Set point: this is the *set point* used as a reference when the device is in *cooling* mode
Heating Set point: this is the *set point* used as a reference when the device is in *heating* mode

The *set point*s may be modified from the *keyboard* by accessing the "SET" submenu (refer to *menu structure*).

Their values must fall within a *range* determined by *parameters Pa H02* – *Pa H01* (*Heating*) and *Pa H04* – *Pa H03* (*Cooling*).

7.2 Dynamic Set point

The regulation algorithm may be used to modify the *set point* automatically on the basis of outdoor conditions.
This modification is achieved by adding a positive or negative offset value to the *set point*, depending on:
- 4-20 mA analogue input (proportionate to a signal set by the user)

or
- temperature of outdoor probe

This function has two purposes: to save energy, or to operate the machine under particularly harsh outdoor temperature conditions.

The *dynamic set point* is active if:
- Activation parameter *Pa H50* = 1

- Probe ST3 (*analogue inputs*) is configured as a *dynamic set point* input (*Pa H13* = 3) or probe ST4 (*analogue inputs*) is configured as an outdoor probe (*Pa H14* = 3)

Control parameters

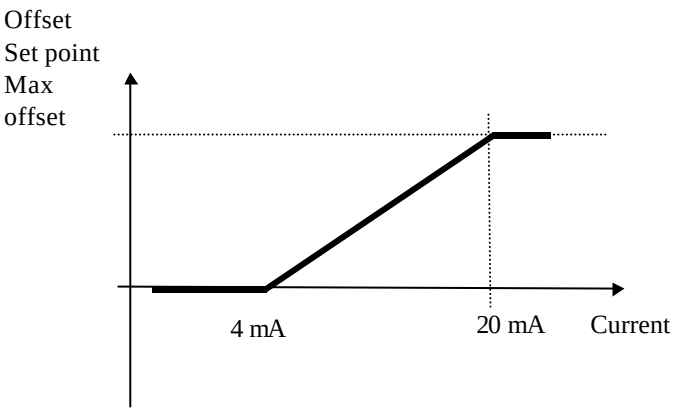
Parameters for control of the *dynamic set point*:

- *Pa H51* = max. offset during *cooling*.
- *Pa H52* = max. offset during *heating*
- *Pa H53* = Outdoor temperature *set point* during *cooling*
- *Pa H54* = Outdoor temperature *set point* during *heating*
- *Pa H55* = Delta of *cooling* temperature
- *Pa H56* = Delta of *heating* temperature

The interaction of these *parameters* is illustrated in the graphs below:

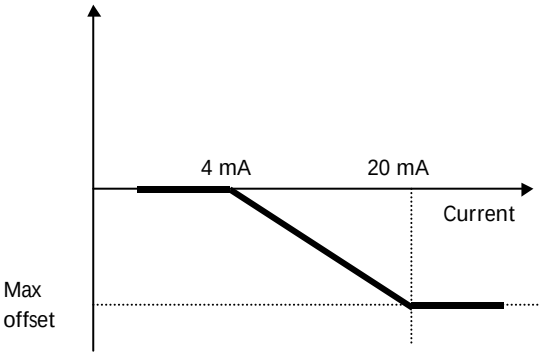
Modification depending on current input with positive offset

Positive Offset (H32>0 or H33>0)



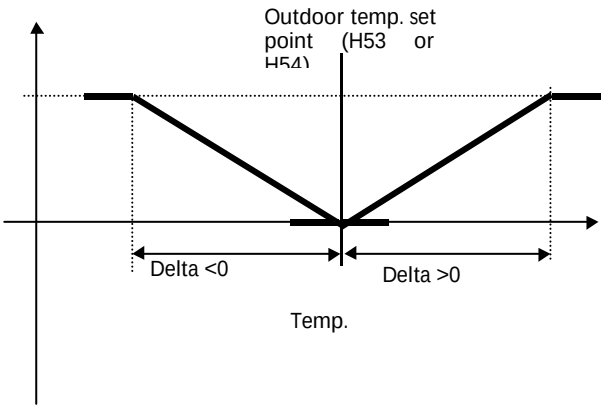
Modification depending on current input with negative offset

Negative Offset (H32<0 or H33<0)

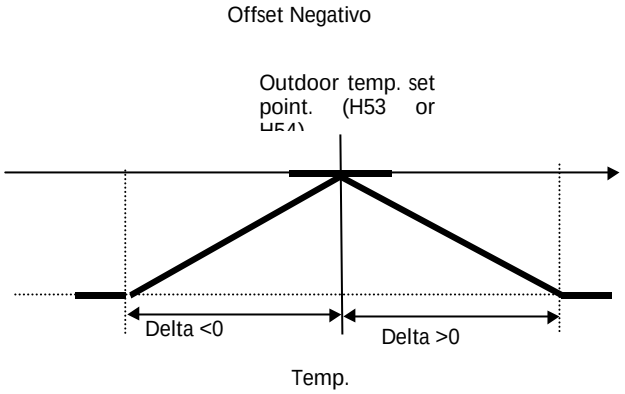


Modification depending on outdoor temperature with positive offset

Positive Offset



Modification depending on outdoor temperature with negative offset



7.3 Load control

We will now look at how to set *parameters* for *load control* on the basis of temperature/pressure conditions detected by probes.

7.3.1 Compressor control – regulation algorithm

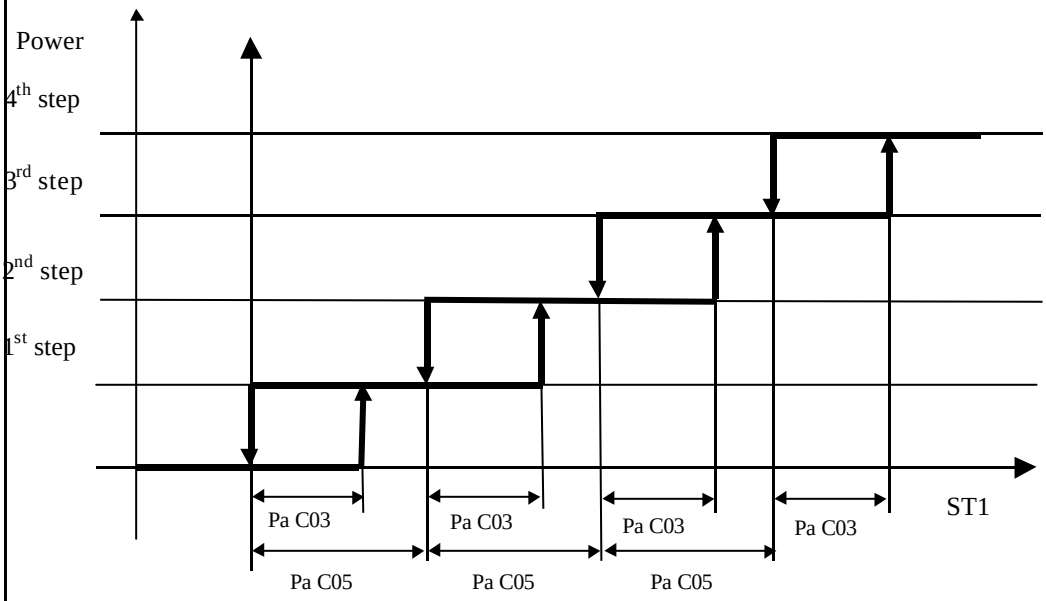
The regulation algorithm calculates the load to be supplied through the *compressors* for both *heating* and *cooling*.

Regulation algorithm in cool mode

REGULATION ALGORITHM IN COOL MODE
If probe ST2 (*analogue inputs*) is not configured as a digital input for requests for *cooling* (*Pa H11*=2) or probe ST1(*analogue inputs*) as a digital input for regulation algorithm requests (*Pa H12*=3), compressor management will depend on ambient temperature and a *SET POINT*.

ST1 = temperature of inflowing water or inlet air
SET COOL= *cooling set point* set from *keyboard*.
Pa C03 = *hysteresis* of *cooling* thermostat
Pa C05 = delta of *power step* intervention

Cooling diagram



If *Pa H01*1 = 3, the *power step* requested will depend on the status of input ST1 (*analogue inputs*).
If *Pa H01*2 = 2, the *power step* requested will depend on the status of input ST2 (*analogue inputs*).
If probe ST5 (*analogue inputs*) is configured as a second step request (*Pa H15* =2), the second step (*power step*) will be requested on the basis of this input. This function will be active only if either *Pa H11*=3 or *Pa H12*=2.
Only motor condensers may be controlled, up to 2 steps only.

Regulation algorithm in heat mode

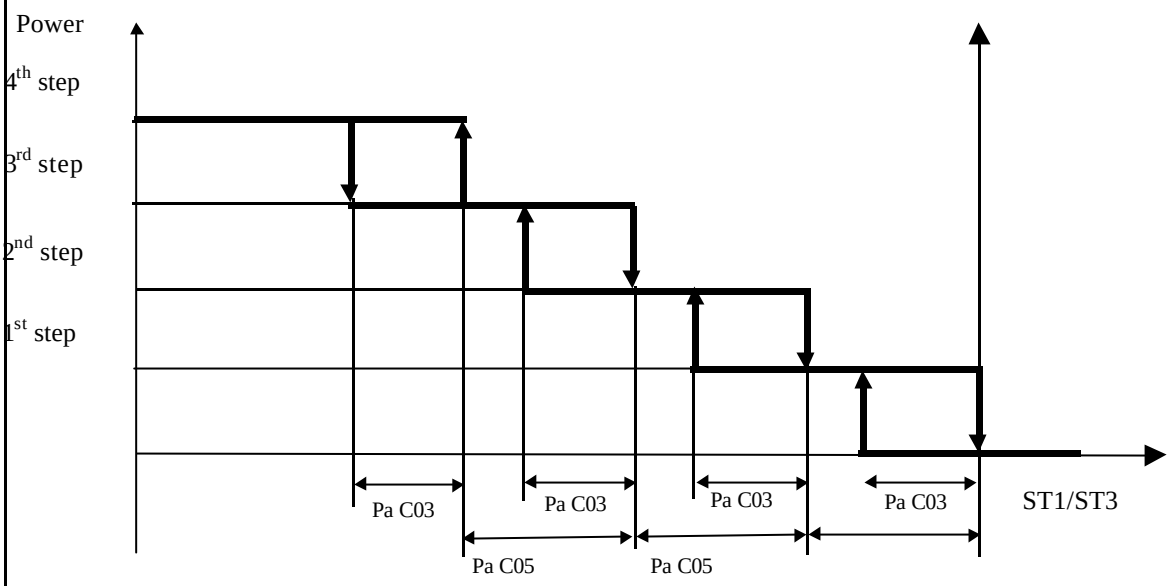
REGULATION ALGORITHM IN HEAT MODE
If probe ST1(*analogue inputs*) is not configured as a digital input for requests for heat (*Pa H05*=2) or digital input for requests for regulation algorithm (*Pa H05*=3), compressor management will depend on

- temperature ST3 (*analogue inputs*), if configuration parameter ST3 = 5 (for water/water manual reversal machines)
- otherwise, temperature ST1(*analogue inputs*)
- a *HEATING set point* which may be set from the *keyboard*

ST1/ST3 =Temperature of inflowing water or inlet air

HEATING **SET =** *Heating set point* that has been set
Pa C04 = *Heating* thermostat *hysteresis*
Pa C05 = Delta of step intervention

Heating diagram



If *Pa H11* = 2-3, the *compressors* will be turned off and on depending on the status of input ST1.
If probe ST5 (*analogue inputs*) is configured as a second step request (*Pa H15* =2), the second step (*power step*) will be requested depending on this input. This function will be active only if *Pa H11*=2,3 or *Pa H12*=2.

Differential temperature control

DIFFERENTIAL TEMPERATURE CONTROL
This function may be used to control temperature according to both ST1(*analogue inputs*) and ST4 (*analogue inputs*). The function will be active

- if ST1 is configured as differential NTC input (*Pa H11* **= 4)**
- if ST4 is configured as outdoor temperature input (*Pa H14* **= 3)**

In this case, the controller will not control on the basis of ST1, but on the basis of the difference between ST1-ST4; if configuration parameter ST3 is equal to 5 (for water/water machines with manual reversal) in *heating* mode the controller will always control on the basis of ST3.
Differential temperature control can be used, for instance, to maintain a constant difference in temperature between the outdoor environment and a liquid being heated or cooled.

A compressor will always be off if:

- It is not associated with a relay (power output)
- The compressor has been shut down (refer to table of *alarms*)
- *Safety timing* is in progress
- The time lapse between pump on and compressor on is in progress (*safety timing*)
- Preventilation is in progress in *cooling* mode
- *Energy 400* is in *stand-by* or off mode
- The parameter for configuration of probe ST1 *Pa H11* = 0 (probe absent)

7.3.2 Condensation fan control

Condensation control is dependent on the condensation temperature or pressure for the circuit.
Fan control will be on if:

- at least one probe per circuit is configured as a condensation probe (pressure or temperature); if not, the fan for the circuit will come ON and go OFF in response to the circuit *compressors*.

Fan control may be independent of the compressor, or it may be carried out in response to requests from *compressors*;
Operating mode is determined by parameter *Pa F05*:

	Value	
	0	**1**
Pa F05: **fan output mode**	if all *compressors* in the circuit are off, the fan is off	condensation control is independent of the compressor

The *cut-off* is bypassed for an amount of time equal to *Pa F12* after the compressor is turned on. If the control requests *cut-off* during this time period, the fan will run at minimum speed.

If parameter *Pa F05* is set to 1, condensation control will be dependent on condensation temperature or pressure, depending on how the following *parameters* are set:

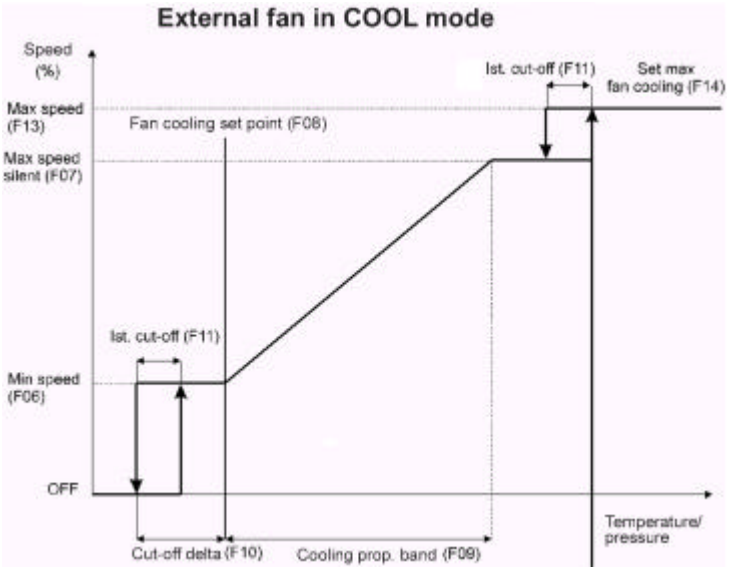
Cool mode

CONDENSATION FAN CONTROL IN COOL MODE
Pa F06 **=** Minimum fan speed in COOL mode;
Pa F07 **=** Maximum silent fan speed in COOL mode
Pa F08 = Minimum fan speed temperature/pressure *set point* in COOL mode
Pa F09 = Fan prop. band in COOL mode

Pa F10 = Fan *cut-off* delta
Pa F11 = *Cut-off hysteresis*.
Pa F13 = Maximum fan speed in COOL mode
Pa F14 = Maximum fan speed temperature/pressure *set point* in COOL mode
An example of interaction of these *parameters* is shown in the figure below:

Fan control in cool mode: diagram

Fan control in cool mode



In *cooling* mode only, if *Pa F05*= 0 (if the compressor is turned off the fan is off), parameter *Pa F21* **(**preventilation time for outdoor fan) is active.
Before turning on the *compressors* in the circuit the fan must be turned on for an amount of time equal to Pa F25; fan speed is proportionate to condensation temperature, but if the control requests *cut-off* during this time period the fan will run at the minimum speed setting.

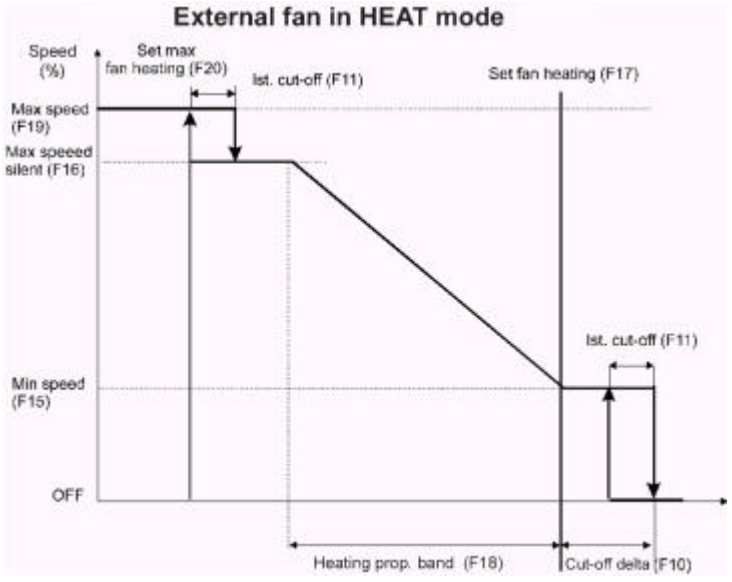
This parameter prevents the compressor from starting up with a condensation temperature that is too high.

Heat mode

CONDENSATION FAN CONTROL IN HEAT MODE
Pa F15 **=** Minimum fan speed in HEAT mode;
Pa F16 **=** Maximum silent fan speed in HEAT mode;
Pa F17 = Minimum fan speed temperature/pressure *set point* in HEAT mode;
Pa F18 = Fan prop. band in HEAT mode;
Pa F10 = Fan *cut-off* delta;
Pa F11 = *Cut-off hysteresis*;
Pa F19 = Maximum fan speed in HEAT mode;
Pa F20 = Maximum fan speed temperature/pressure *set point* in HEAT mode.
An example of interaction of these *parameters* is shown in the figure below:

Fan control in heat mode: diagram

Fan control in heat mode



If circuit is in *defrost* mode, the fan is OFF.

The *cut-off* is bypassed for an amount of time equal to *Pa F12* after the compressor is turned on.
If the control requests *cut-off* during this time period, the fan will run at minimum speed.

The fan will always be off if:
there is an alarm indicating that a *condensation fan* has shut down (refer to table of *alarms*).
Energy 400 is on *stand-by* or off.

7.3.3 Combined or Separate Condensation

Parameter *Pa F22* may be used to configure a dual circuit machine with a combined condenser.

	Value	
	0	**1**
Pa F22: **condensation type**	separate condensers	combined condenser

If *Pa F22* = 0 the two fans are independent and are controlled by condensation pressure/temperature and the status of the *compressors* in the circuits.
If *Pa F22*= 1 the *outputs* of the 2 fans are in parallel and will be controlled as follows:
by the greater of the condensation probes in the circuits in *cooling* **mode**
by the smaller of the condensation probes in the circuits in *heating* **mode**

If one of the 2 circuits does not have a condensation probe a configuration alarm will be generated (refer to table of *alarms*).

7.3.4 Hydraulic pump control

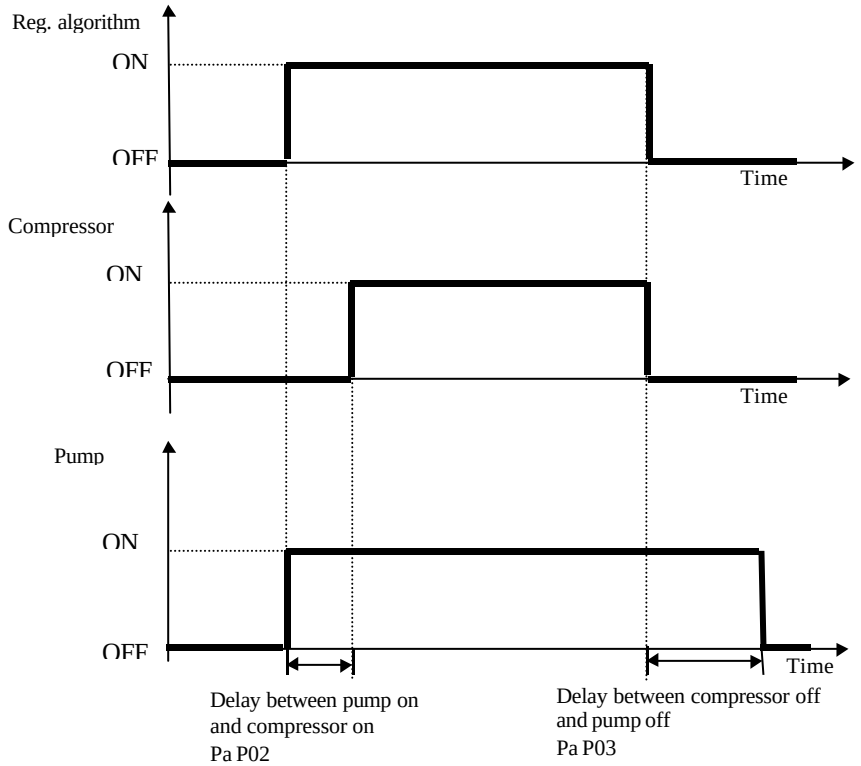
If the pump is configured for continuous operation (*Pa P01* = 0) it will stay on at all times; if not (*Pa P01* = 1) it will be turned on in response to a request from the regulation algorithm.

Interaction between the pump, the *compressors* and the regulation algorithm status is determined by the following *parameters*:

- *Pa P02*: Delay between pump on and *compressors* on.
- *Pa P03*: Delay between regulation algorithm off and pump off.

diagram

An example is provided in the diagram below:



Errore. Il collegamento non è valido.

During a *defrost*, when the compressor is off, the pump will stay on.

The pump will go off if:
- There is a pump shut-down alarm, such as a flow switch alarm requiring *manual reset* (refer to table of *alarms*)

- The instrument is on *stand-by* or off (it goes off after the delay determined by *Pa P03*)

7.3.5 Anti-freeze/supplementary electrical heater control

Energy 400 can control 2 anti-freeze electrical heaters;
Each electrical heater is controlled with its own *set point*, which is different for *heating* and *cooling* modes, by means of the following *parameters* :

- *Pa r07*: *set point* of electrical heater 1 in *heating* mode
- *Pa r08*: *set point* of electrical heater 1 in *cooling* mode
- *Pa r13*: *set point* of electrical heater 2 in *heating* mode
- *Pa r14*: *set point* of electrical heater 2 in *cooling* mode

The two *set point*s of the anti-freeze electrical heaters fall within a maximum and a minimum value which the user may set in the form of the following *parameters*:

- *Pa r09*: maximum *set point* for anti-freeze electrical heater
- *Pa r10*: minimum *set point* for anti-freeze electrical heater

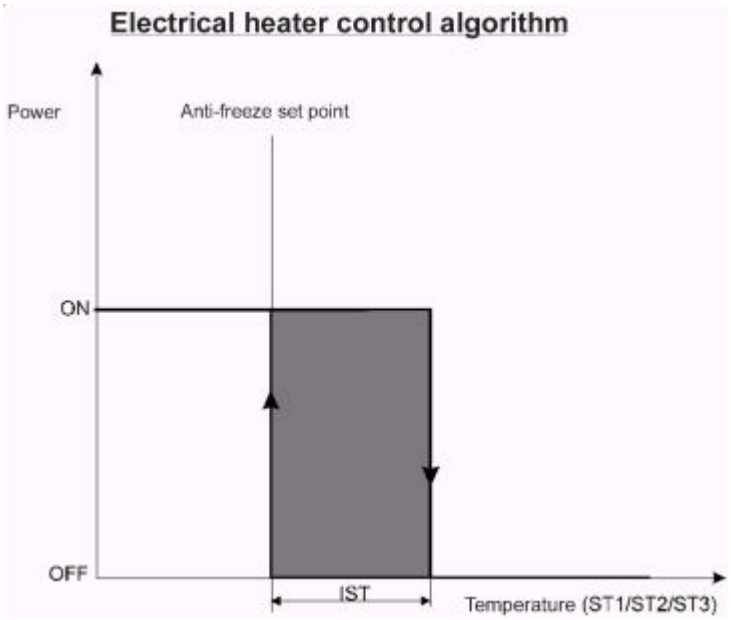
When off or on *stand-by*. control is based on the *cooling set point* and the control probe used in *heating* mode.

Parameter *Pa R11* determines *hysteresis* around the *set point*s for the *anti-freeze/supplementary electrical heaters*.

diagram

An example of operation is shown in the diagram below

Diagram illustrating *anti-freeze/supplementary electrical heaters* control



Parallel electrical heaters

PARALLEL ELECTRICAL HEATERS
Parameter r12 enables the *parallel electrical heaters* function..

This function is useful if the system incorporates 2 hydraulic circuits, each with its own anti-freeze probe, and there is only one anti-freeze electrical heater.

The following conditions must apply for the function to be active:

- *Pa r12* = 1
- *Pa r05* other than 0
- *Pa r06* other than 0.

Control is based on the minimum value detected by the 2 probes, using the *set point*s of electrical heaters 1 (*Pa r07* and *Pa r08*)

Supplementary electrical heaters

If *Pa r15*= 1 the electrical heaters have a dual function, as anti-freeze electrical heaters and *supplementary electrical heaters*. If *Pa r15* = 1 and the system is in *heating* mode., electrical heater 1 will start up under the command of its own control or if ST1 <(SET *HEATING-Pa r14*) while heater 2) will start up if ST1 <(SET *HEATING-Pa r15*) . The control *hysteresis* is *Pa C04* (*heating* control *hysteresis*).

7.3.6 Reversing valve control

The *reversing valves* are turned off if *Energy 400* is off or on *stand-by*;
The valves are ON in *cooling* mode and OFF in *heating* and *defrost* modes.

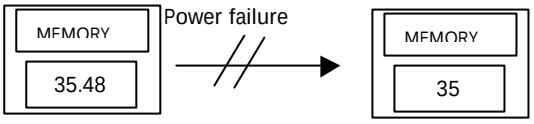
8 FUNCTIONS

8.1 Recording hours of operation

The devices stores the number of hours of operation of the following in *permanent memory*:
- *hydraulic pump*
- *compressors*.

It is precise to within one minute.
Hours of operation may be displayed by entering the appropriate menu with the label Ohr (refer to *menu structure*).
The whole value is displayed if it is less than 999 hours; if it exceeds this value, the hundreds of hours will be shown and the decimal point will appear:
For example, 1234 hours will be displayed as follows:

To set the number of hours to zero, hold the DOWN key (refer to *keys*) down for two seconds while displaying the number of hours of operation.



In the event of a power failure, the latest fraction of an hour recorded is set to 0, so that duration is rounded down:

8.2 Defrost

The *defrost* function is active in *heating* mode only.
It is used to prevent ice formation on the surface of the external exchanger, which can occur in locations with low temperatures and high humidity and will considerably reduce the machine's thermodynamic performance, creating a risk of damage to the machine.

Defrost start and end depends on the condensation probe values (refer to condensation probes– *defrost*) and the settings of the *parameters* listed below:

8.2.1 Defrost start

The *defrost start*s as a result of three *parameters*:
- *Pa d02* : temperature/pressure at which *defrost start*s
- *Pa d03* : *defrost* interval

When the probe detects temperature/pressure values below the value of parameter *Pa d02* it starts the timer, and when the number of minutes determined by parameter *Pa d03* has expired the *defrost* will start;

Stopping timer

The timer will stop if:
- Temperature/pressure rises above the value of parameter *Pa d02*
- The compressor is turned off

Setting timer to zero

The timer will be set to zero if:
- a *defrost* cycle is completed
- "*Energy 400*" is turned off
- operating mode is changed (refer to *operating modes*)
- temperature rises above the value of parameter *Pa d04* (*defrost end* temperature/pressure)

Defrost: compressor management

During the *defrost* the *compressors* are handled as follows:
- combined *defrost*: all *compressors* are turned on at full power;
- separate *defrost*: all *compressors* in the circuit being defrosted are turned on at full power;

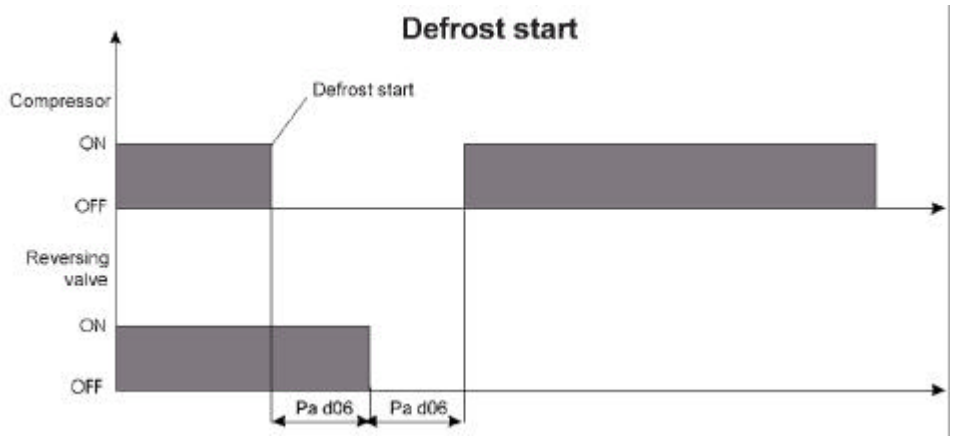
there may be a delay between compressor coming on and *Defrost start* imposed by parameter Pa d11

Defrost will take place only if the following conditions are met: :
- The *safety timing* of *compressors* in the circuit must be 0
- The delay between circuit defrosts must have expired since the last circuit *defrost* (*Pa d08*)

On a dual circuit machine with combined *defrost*, the following condition must apply:
- in the circuit for which *defrost start* is not requested, compressor safety time = 0 (refer to *safety timing*) so that the two circuits may both start a *defrost* at the same time.

If at the time of *defrost start* the compressor-4-way valve delay time *Pa d06* **= 0,** the compressor will stay on; if not, the adjustment shown in the diagram below will be carried out.

diagram



8.2.2 Control during defrost

During the *defrost* cycle *loads* are controlled as described below:

Compressors

compressors in the circuit for which *defrost* is underway will be turned on to full power, if not already on at full power

Reversing valve

The *reversing valve* in the circuit for which *defrost* is underway will behave the way it does in the summer cycle.
When the valve is reversed, a timer begins counting the minimum by-pass time for the circuit involved, equal to "minimum by-pass time during *cooling*" (*Pa A01*).

Fans

If the condensation pressure detected falls below (*Pa F23* - *Pa F24*), the fan will be OFF; if it exceeds *Pa F23*, the fan will be ON. At the end of the drip stage, if parameter *Pa D07* is not 0 the fans will operate at full speed for an amount of time equal to Pa F25 in order to remove water from the batteries as quickly as possible.
If there are no pressure probes on the machine, this will be applied to temperature.

8.2.3 Defrost end

Defrost end may be determined by temperature/pressure values read by analogue probes ST3, ST2, ST6 (*analogue inputs*) or by digital input (*digital inputs*).

The *configuration parameters* are:

- *Pa d09* : Circuit 1 *defrost end* probe
- Pa d10: Circuit 2 *defrost end* probe

Parameter configuration

Possible values and meanings of these *parameters* are shown below:

Value *Parameters*	**Description**
0	*defrost end* in response to digital input
1	*defrost end* in response to ST3
2	*defrost end* in response to ST4
3	*defrost end* in response to ST6

If *Pa d09*=0 (*defrost end* in response to digital input) the digital input configured as "End of *defrost* circuit 1" (*digital inputs*) will be taken into consideration; if Pa d10=0 input "circuit 2 *defrost end*"(*digital inputs*) .
In this configuration, as soon as the input becomes active the circuit will have a *defrost end*.

If an analogue input is selected for *defrost end*, the *defrost* will end will pressure/temperature rises above the value of parameter *Pa d04* (*defrost end* temperature/pressure).

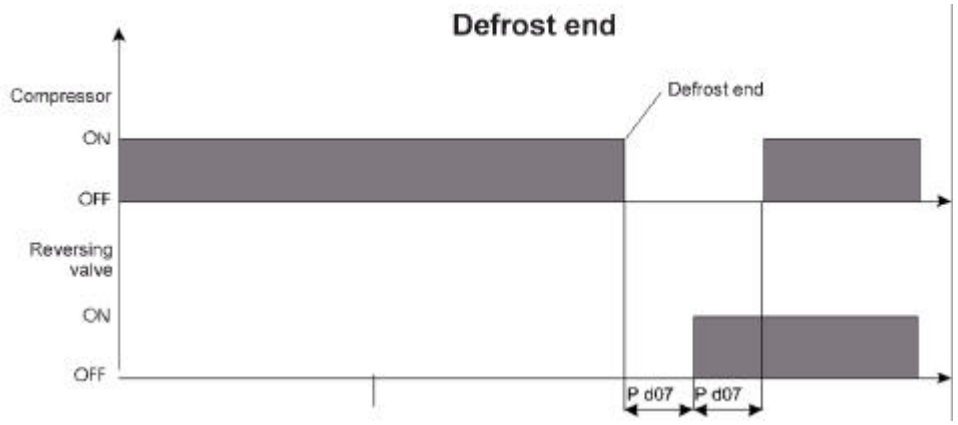
If the input is not configured, *defrost* will end only when pressure/temperature rises above the maximum duration set by parameter *Pa d05*

Defrost will always end if duration exceeds the maximum duration set by parameter *Pa D05*.

Drip time

After *defrost end*, if *drip time Pa d07*= 0 the *compressors* will stay on; if not, the adjustment shown in the figure below will take place:

diagram


Defrost end
Compressor
ON
OFF
Defrost end
Reversing valve
ON
OFF
P d07
P d07

9 PARAMETERS

Parameters make the "*Energy 400*" a fully configurable device.
They may be modified through:

- instrument *keyboard*
- Personal computer (with a suitable connection and "*Param manager*" software)

We will now take a detailed look at all the *parameters*, divided by category.

9.1 Description of Parameters

CONFIGURATION PARAMETERS:
Determine the features of the machine.

If one or more of the *parameters* in this category are modified, the cotnroller must be switched off after the modification and switched on again to ensure correct operation.

Pa H01 **Maximum** *set point* **during "***heating***"**
Upper limit on *set point* in "*heating*" mode

Pa H02 **Minimum** *set point* **during "***heating***"**
Lower limit on *set point* in "*heating*" mode

Pa H03 **Maximum** *set point* **during "***cooling***"**
Upper limit on *set point* in "*cooling*" mode

Pa H04 **Minimum** *set point* **during "***cooling***"**
Lower limit on *set point* in "*cooling*" mode

Pa H05 **Number of circuits on machine (*)**
Number of *cooling* circuits
0= not permitted
1= 1 *cooling* circuit
2= 2 *cooling* circuits

Pa H06 **Number of** *compressors* **per circuit (*)**
0= no *compressors*
1= 1 compressor
2= 2 *compressors*
3= 3 *compressors*
4= 4 *compressors*

Pa H07 **Number of capacity steps per compressor (*)**
0= no capacity steps
1= 1 capacity step per compressor
2= 2 capacity steps per compressor
3= 3 capacity steps per compressor

Pa H08 **Compressor on sequence**
0= depending on hours of operation
1= unvaried on sequence

Pa H09 **Compressor** *selection* **algorithm**
0= circuit saturation
1= circuit balancing

Pa H11 **ST1 configuration**
Used to configure analogue input ST1
0= No probe
1= Inflowing air/water analogue input
2= *Heating* request digital input
3= Regulation algorithm request digital input
4= NTC differential input

Pa H12 **ST2 configuration**
0= No probe
1= Circuit 1 outflowing water/antifreeze/inlet air analogue input
2= *Cooling* request digital input

Pa H13 **ST3 configuration**
0= No probe
1= Condensation control analogue input
2= 4...20 mA condensation input
3= 4...20 mA *dynamic set point* input
4= Antifreeze analogue input for water-water machines with gas reversal, circuit 1
5= Regulation algorithm input in "*heating*" mode for water-water machines with manual reversal

Pa H14 **ST4 configuration**
0= No probe
1= Condensation control analogue input
2= Multifunctional digital input
3= Outdoor temperature analogue input

Pa H15 **ST5 configuration**
0= No probe
1= Outflowing water/anti-freeze/inlet air analogue input, circuit 2

Pa H16 **ST6 configuration**
0= No probe
1= Condensation control analogue input
2= 4...20 mA condensation input

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* non sono ammesse configurazioni macchina con numero di gradini superiore a 4

3= Not permitted
4= Antifreeze analogue input for water-water machines with gas reversal, circuit 2

Pa H17 **Bottom of scale pressure value**
Pressure value corresponding to an analogue input value (ST3 or ST6) on the 20mA input (if configured as a current input).
Example
if using a pressure transducer with limits of 0-30.0 bar/4-20mA, set PaH17=300

Pa H18 **Polarity of *digital inputs* ID1,ID2,ID3,ID4**
Pa H19 **Polarity of *digital inputs* ID5,ID6,ID7,ID8**
Pa H20 **Polarity of *digital inputs* ID9,ID10,ID11,ST4**
Pa H21 **Polarity of *digital inputs* ID12,ID13,ID14,ID15**
These *parameters* may be used to select the polarity which will activate the *digital inputs* to suit them to various operating requirements. Refer to *Digital inputs: polarity* when setting input polarity.

Pa H23 **Configuration of digital input ID1**
Pa H24 **Configuration of digital input ID2**
Pa H25 **Configuration of digital input ID3**
Pa H26 **Configuration of digital input ID4**
Pa H27 **Configuration of digital input ID5**
Pa H28 **Configuration of digital input ID6**
Pa H29 **Configuration of digital input ID7**
Pa H30 **Configuration of digital input ID8**
Pa H31 **Configuration of digital input ID9**
Pa H32 **Configuration of digital input ID10**
Pa H33 **Configuration of digital input ID11**
Pa H34 **Configuration of digital input ST4 if configured as digital**

0	Input disabled	12	Low pressure circuit 1
1	Flow switch	13	Low pressure circuit 2
2	Remote OFF	14	High pressure compressor 1
3	Remote Heat/Cool	15	High pressure compressor 2
4	Thermal switch compressor 1	16	High pressure compressor 3
5	Thermal switch compressor 2	17	High pressure compressor 4
6	Thermal switch compressor 3	18	*Defrost end* circuit 1
7	Thermal switch compressor 4	19	*Defrost end* circuit 2
8	Thermal switch fan circuit 1	20	Request for *power step* 2
9	Thermal switch fan circuit 2	21	Request for *power step* 3
10	High pressure circuit 1	22	Request for *power step* 4
11	High pressure circuit 2		

Pa H35 **Configuration of output RL2**
Pa H36 **Configuration of output RL3**
Pa H37 **Configuration of output RL4**
Pa H38 **Configuration of output RL5**
Pa H39 **Configuration of output RL6**
Pa H40 **Configuration of output RL7**
These *parameters* are used to assign various *functions* to relays as required by the type of application.
0= Not in use
1= *Reversing valve* circuit 1
2= *Reversing valve* circuit 2
3= *Condensation fan* circuit 1
4= *Condensation fan* circuit 2
5= Electrical heater 1
6= Electrical heater 2
7= *Hydraulic pump*
8= Evaporator fan
9= *Power Step* 2
10= *Power Step* 3
11= *Power Step* 4

Pa H41 **Polarity of output RL2**
Pa H42 **Polarity of output RL3**
Pa H43 **Polarity of output RL4**
Pa H44 **Polarity of output RL5**
Pa H45 **Polarity of output RL8**
Relay polarity may be set for the corresponding *outputs*.
0=relay on if output active
1=relay off if output not active

Pa H46 **Configuration of analogue output 1 (AN1 or TK1)**
Pa H47 **Configuration of analogue output 2 (AN2 or TK2)**
Condensation fan control outputs are available with 2 types of signal.
0= Suignal for phase cut fan control
1= 4-20mA output

Pa H48 **Not in use**
Pa H49 *Selection* **of operating mode**
0= *Selection* from *keyboard*
1= *Selection* from digital input

Pa H50 **Enable** *dynamic set point*
If enabled, this function permits automatic variation of the working *set point* depending on outdoor temperature or on a 4-20mA analogue input. The parameter has no meaning if PaH13≠3 or PaH14≠3.
0= Function disabled
1= Function enabled

Pa H51 **Maximum** *dynamic set point* **offset in** *cooling* **mode**

The maximum value that may be added to the *set point* in *cooling* mode (COO) when the *DYNAMIC SET POINT* function is enabled.

Pa H52 **Maximum** *dynamic set point* **offset in** *heating* **mode**
The maximum value that may be added to the *set point* in *heating* mode (HEA) when the *DYNAMIC SET POINT* function is enabled.

Pa H53 **Outdoor temperature** *set point* **in** *cooling* **mode**
The outdoor temperature value on the basis of which ...
The parameter is significant only if the *dynamic set point* function is enabled and probe ST4 is configured as an outdoor temperature probe.

Pa H54 **Outdoor temperature** *set point* **in** *heating* **mode**
The parameter is significant only if the *dynamic set point* function is enabled and probe ST4 is configured as an outdoor temperature probe.

Pa H55 **Outdoor temperature differential in** *cooling* **mode**
The parameter is significant only if the *dynamic set point* function is enabled and probe ST4 is configured as an outdoor temperature probe.

Pa H56 **Outdoor temperature differential in** *heating* **mode**
The parameter is significant only if the *set point* function is enabled and probe ST4 is configured as an outdoor temperature probe.

Pa H57 **Offset ST1,**
Pa H58 **Offset ST2,**
Pa H59 **Offset ST3**
These *parameters* may be used to compensate the error that may occur between the temperature or pressure reading and the actual temperature or pressure.

Pa H60 **Offset ST4**
Pa H61 **Offset ST5**
These *parameters* may be used to compensate the error that may occur between the temperature reading and the actual temperature.

Pa H62 **Offset ST6**
This parameter may be used to compensate the error that may occur between the temperature (or pressure) reading and the actual temperture or pressure.

Pa H63 **Mains frequency**
Mains frequency 50 Hz
Mains frequency 60 Hz

Pa H64 *Selection* **°C or °F**
0= degrees °C
1= degrees °F

Pa H65 **Family serial address,**
Pa H66 **Device serial address**
These *parameters* may be used to address the device when connected to a personal computer or supervision system. Normally both are 0.

Pa H67 **User password**
May be used to enter a password for access to level two *parameters*, and to copy *parameters* from the instrument to the *copy card*.

Pa H68 *Copy card* **write password**
The password that must be entered to copy *parameters* to the *copy card*.

Pa H68 **Presence of** *keyboard*

ALARM PARAMETERS:

Pa A01 **Low pressure pressure switch by-pass time.**
Determines the delay between starting up the compressor and starting up the low pressure digital alarm *diagnostics*. Expressed in seconds.

Pa A02 **Low pressure** *alarm events per hour*
Used to set the number of low pressure digital *alarm events per hour* beyond which the system will switch from automatic *reset* to *manual reset*.

Pa A03 **Bypass pump activation flow switch**
Determines the delay between activation of the *hydraulic pump* and activation of the flow switch alarm *diagnostics*. Expressed in seconds.

Pa A04 **Duration of active flow switch input**
May be used to set the amount of time for which the flow switch digital input must remain *active* to generate a flow switch alarm. The timer starts after the flow switch by-pass time. Expressed in seconds.

Pa A05 **Duration of inactive flow switch input**
May be used to set the time for which the flow switch digital input must remain *inactive* to be included in the corresponding alarm. Expressed in seconds.

Pa A06 **Number of flow switch** *alarms***/hour**
May be used to set the number of flow switch *digital alarms* per hour after which the alarm is switched from automatic to *manual reset*. When this occurs, the *hydraulic pump* is deactivated.

Pa A07 **By-pass compressor thermal switch following compressor on**
Determines the delay between compressor activation and activation of the compressor thermal switch digital *diagnostics* alarm. Expressed in seconds.

Pa A08 **Compressor thermal switch** *alarm events per hour*
May be used to set a number of compressor thermal switch *alarm events per hour* beyond which the alarm is switched from automatic to *manual reset*.

Pa A09 **Number of fan thermal switch events per hour**
May be used to set a number of fan thermal events per hour beyond which the alarm is switched from automatic to *manual reset*.

Pa A10 **Anti-freeze alarm by-pass**
Determines the delay between turning on the machine (*selection* of an operating mode or switch from OFF->ON) and activation of the compressor thermal switch digital alarm *diagnostics*. Expressed in seconds.

Pa A11 **Anti-freeze alarm** *set point*

May be used to set the temperature below which the anti-freeze alarm is triggered.

Pa A12 **Anti-freeze alarm** *hysteresis*
May be used to set the differential value of the anti-freeze alarm.

Pa A13 **Anti-freeze** *alarm events per hour*
May be used to set a number of anti-freeze *alarm events per hour* beyond which the alarm is switched from automatic to *manual reset*.

Pa A14 **Analogue input high pressure/temperature activation** *set point*
May be used to set a condensation pressure/temperature value beyond which the high pressure alarm will be triggered.

Pa A15 **Analogue input high pressure/temperature** *hysteresis*
May be used to set the differential for the analogue high pressure alarm.

Pa A16 **Analogue input high pressure/temperature activation bypass**
Determines the delay after turning on of the first compressor in the *cooling* circuit and activation of the corresponding analogue input low pressure/temperature analogue alarm *diagnostics*.

Pa A17 **Analogue input low pressure/temperature activation** *set point*
May be used to set a temperature/pressure value below which the low pressure alarm will be triggered.

Pa A18 **Analogue input low pressure/temperature** *hysteresis*
May be used to set the differential for the analogue low pressure/temperature alarm.

Pa A19 **Number of analogue input low pressure** *alarm events per hour*
May be used to set a number of low pressure analogue *alarm events per hour* beyond which the alarm will be switched from automatic to *manual reset*.

Pa A20 **Machine out of coolant differential**
If the difference between the absolute value of the *set point* and of the control probe exceeds this parameter, the machine out of coolant timer will start.

Pa A21 **Bypass machine out of coolant**
Determines the delay between the turning on of the first compressor in the corresponding *cooling* circuit and activation of the machine out of coolant alarm *diagnostics*. Expressed in minutes.

Pa A22 **Duration of machine out of coolant**
Determines the duration of the condition described under parameter A20 beyond which the machine out of coolant alarm will be triggered.

Pa A23 **Machine out of coolant alarm triggered**
Enables machine out of coolant alarm *diagnostics*
0= *diagnostics* disabled
1= *diagnostics* enabled

Pa A24 **Enable low pressure alarm during defrosting**
Enables the minimum alarm during defrosting.
0= Low pressure alarm *diagnostics* disabled during defrosting
1= Low pressure alarm *diagnostics* enabled during defrosting

Pa A25 **Input over-temperature** *set point*
Temperature value ST1 above which the high temperature alarm **E46** is triggered**.**

Pa A26 **Input over-temperature duration**
Determines the duration of the condition described for parameter A25 beyond which the input over-temperature alarm is triggered.

COMPRESSOR PARAMETERS

Pa C01 **OFF-ON safety time**
The minimum amount of time that must pass between turning off the compressor and turning it on again. Expressed in tens of seconds.

Pa C02 **ON-ON safety time**
The minimum amount of time that must pass between turning the compressor on and turning it on again. Expressed in tens of seconds.

Pa C03 *Hysteresis* **regulation algorithm during** *cooling*
May be used to select intervention differential in *cooling* mode.

Pa C04 *Hysteresis* **regulation algorithm during** *heating*
May be used to select intervention differential in *heating* mode.

Pa C05 **Regulation algorithm step intervention differential**
May be used to set a temperature differential in relation to the *set point* beyond which the second step is activated.

Pa C06 **Compressor on interval**
May be used to set a delay between turning on of two *compressors*.

Pa C07 **Compressor off interval**
May be used to set a delay between turning off of two *compressors*.

Pa C08 **Capacity step on interval**
May be used to set a delay between turning on of compressor and of capacity steps.

FAN CONTROL PARAMETERS:

Pa F01 **Fan output configuration**
0 = proportional fan output (from 0 to 100% depending on *parameters*)
1 = fan output "on-off"; in this mode the regulation algorithm performs the same calculation as in proportional fan output, but if the result is greater than 0, regulation algorithmoutput will be 100.
2 = on-off operation in response to request from compressor. In this mode output is 0 if no compressor in the circuit is on, or 100% if at least one compressor in the circuit is on.

Pa F02 **Fan** *pick-up* **time**
Time for which fan runs at maximum speed after starting up. Expressed in seconds/10.

Pa F03 **Fan** *phase shift*
This parameter may be used to calibrate fan control output in proportion to the type of fan in use, adjusting it to suit the fan's typical current/voltage *phase shift*.

Pa F04 *Impulse duration* **of triac on**
May be used to vary the length of the impulse from the triac command.

Pa F05 **Functioning in resposne to compressor request**

0= if compressor is off, fan is off
1= condensation control independent of compressor

Pa F06 **Minimum speed during** *cooling*
Minimum value of proportional fan control during *cooling*. Expressed as a percentage of the power supply voltage, from 0 to 100%,.

Pa F07 **Maximum silent speed during** *cooling*
Maximum value of proportional fan control during *cooling*. Expressed as a percentage of the power supply voltage, from 0 to 100%,.

Pa F08 **Minimum fan speed temperature/pressure** *set point* **during** *cooling*
Condensation pressure/temperature value below which the fan runs at minimum *cooling* speed.

Pa F09 **Proportional band during** *cooling*
Temperature/pressure differential corresponding to change from minimum to silent maximum fan speed during *cooling* (F07).

Pa F10 **Fan** *cut-off* **differential**
Condensation temperature/pressure differential in relation to temperature/pressure *set point* (F08 or F14) beyond which fan is cut off.

Pa F11 *Cut-off hysteresis***.**
Condensation temperature/pressure differential for *cut-off*.

Pa F12 *Cut-off* **bypass time**
Determines the amount of time after fan start-up during which fan *cut-off* is excluded. Expressed in seconds.

Pa F13 **Maximum speed during** *cooling*
May be used to set a speed step corresponding to a given temperature/pressure value in *cooling* mode.

Pa F14 **Maximum fan speed temperature/pressure during** *cooling*
Condensation pressure/temperature value corresponding to the fan speed set for par. F13.

Pa F15 **Minimum speed during** *heating*
Minimum proportional fan control value in *heating* mode. Expressed as a percentage of the power supply voltage, from 0 to 100%,.

Pa F16 **Maximum silent speed during** *heating*
Maximum value of proportional fan control during *heating*. Expressed as a percentage of the power supply voltage, from 0 to 100%,.

Pa F17 **Minimum fan speed temperature/pressure** *set point* **during** *heating*
Condensation temperature/pressure value above which the fan operates at minimum *heating* speed.

Pa F18 **Proportional band during** *heating*
Temperature/pressure differential corresponding to a change from minimum to maximum silent fan speed during *heating* (F16).

Pa F19 **Maximum speed during** *heating*
May be used to set a speed step corresponding to a given temperature/pressure value during *heating*.

Pa F20 **Maximum fan speed temperature/pressure** *set point* **during** *heating*
Condensation temperature/pressure value corresponding to the fan speed set for par. F19.

Pa F21 **Preventilation in** *cooling* **mode**
May be used to set a preventilation time in *cooling* mode before compressor combines on in order to prevent....

Pa F22 **Combined or separate fan control**
Parameter F22 may be used to configure dual circuit machines with a single condenser.
Parameter F22 condensation type
0= separate condensers
1= combined condenser.
If *Pa F22* = 0 the fans are independent and depend on condensation pressure/temperature and the status of the *compressors* in the circuits. If *Pa F22*= 1 the *outputs* of the 2 fans are parallel and they are controlled:
on the basis of the greater of the two circuit condensation probes **in** *cooling* **mode**
on the basis of the smaller of the two circuit condensation probes **in** *heating* **mode**
If there is no condensation probe in one of the 2 circuits, a configuration alarm will be generated.

Pa F23 **Fan activation temperature/pressure** *set point* **during defrosting**
During defrosting, if temperature/pressure exceeds the "fan activation during defrosting" threshold (*Pa F23*) the fans will come on at full power.

Pa F24 **Fan activation** *hysteresis* **during defrosting**
Condensation temperature/pressure differential for fan *control during defrost*ing.

PUMP PARAMETERS

Pa P01 **Pump operating mode**
May be used to determine pump operating mode:
0=continuous operation
1=operation in response to a request from the regulation algorithm

Pa P02 **Delay between pump ON and compressor ON**
May be used to set a delay between starting a pump and starting a compressor, expressed in seconds.

Pa P03 **Delay between compressor OFF and pump OFF**
May be used to set a delay between turning off a compressor and turning off a pump, expressed in seconds.

ANTI-FREEZE/BOILER *PARAMETERS*

Pa r01 **Configuration of electrical heaters in** *defrost* **mode**
Determines electrical heater operation during defrosting
0=come on only in response to a request from the regulation algorithm
1=always on during defrosting

Pa r02 **Configuration of electrical heaters on in** *cooling* **mode**
Determines electrical heater operation in *cooling* mode
0=off during *cooling*
1=on during *cooling* (in response to anti-freeze electrical heater regulation algorithm)

Pa r03 **Configuration of electrical heaters on in** *heating* **mode**
Determines electrical heater operation in *heating* mode

0=off during *heating*
1= on during *cooling* (in response to anti-freeze electrical heater regulation algorithm)

Pa r04 **Configuration of electrical heater 1 control probe**

Pa r05 **Configuration of electrical heater 2 control probe**

Determines the control probes belonging to electrical heaters in *heating* mode
0= Not present
1=Control probe ST1
2=Control probe ST2
3= Control probe ST5

Pa r06 **Configuration of electrical heaters when OFF or on** *stand-by*

Determines the status of electrical heaters when the instrument is OFF or on *stand-by*
0=Always off when OFF or on *stand-by*
1=On when OFF or on *stand-by* (in response to anti-freeze electrical heater control algorithm)

Pa r07 *Set point* **of anti-freeze electrial heater 1 in** *heating* **mode**

Temperature value below which anti-freeze electrical heater 1 comes on in *heating* mode.

Pa r08 *Set point* **of anti-freeze electrical heater 1 in** *cooling* **mode**

Temperature value below which anti-freeze electrical heater 1 comes on in *cooling* mode.

Pa r09 **Maximum** *set point* **of anti-freeze electrical heaters**

Determines the maximum setting of the anti-freeze electrical heater *set point*s.

Pa r10 **Minimum** *set point* **of anti-freeze electrical heaters**

Determines the minimumsetting of the anti-freeze electrcial heater *set point*s.

Pa r11 **Anti-freeze heater** *hysteresis*

Anti-freeze electrical heater control algorithm *hysteresis*.

Pa r12 *Set point* **of external anti-freeze electrical heaters**

Temperature below which anti-freeze electrical heaters in the secondary circuit come on.

Pa r13 *Set point* **of electrical heater 2 in** *heating* **mode**

Temperature below which anti-freeze electrical heaters 2 come on in *heating* mode.

Pa r14 *Set point* **of electrical heater 2 in** *cooling* **mode**

Temperature below which anti-freeze electrical heaters 2 come on in *cooling* mode.

Pa r15 **Enable** *supplementary electrical heaters*

DEFROST PARAMETERS::

Pa d01 *Defrost* **enabled**

0= *defrost* function enabled
1= *defrost* function disabled

Pa d02 *Defrost start* **temperature / pressure**

Temperature/pressure below which the *defrost* cycle is started.

Pa d03 *Defrost* **interval (response time)**

Duration for which probe remains below *defrost start* temperature/pressure, expressed in minutes.

Pa d04 *Defrost end* **temperature/pressure**

Temperature/pressure above which *defrost end*s.

Pa d05 **Maximum** *defrost* **time (time-out)**

Maximum duration of *defrost* in minutes.

Pa d06 **Compressor-***reversing valve* **wait time (anti-bleeding)**

Wait time between compressor going off and reversal of the 4-way valve at the beginning of the *defrost* cycle.

Pa d07 *Drip time*

Wait time at the end of the *defrost* cycle between the compressor going off and the reversal of the 4-way valve.

Pa d08 **Temperature at which** *defrost start***s if** *Pa H49***= 1**

Temperature below which the *defrost* cycle is started.

Pa d09 **Temperature at which** *defrost end***s if** *Pa H49***=1**

Temperature above which the *defrost* cycle is ended.

9.2 Parameters table

All "*Energy 400*" *parameters* are listed in the table below.

Configuration parameters

CONFIGURATION PARAMETERS *				
Par.	Description	Value	Limits	Unit of meas.
Pa H01	Maximum *set point* during *heating*		H02 ÷ 90.0	°C
Pa H02	Minimum *set point* during *heating*		-40.0 ÷ H01	°C
Pa H03	Maximum *set point* during *cooling*		H04 ÷ 90.0	°C
Pa H04	Minimum *set point* during *cooling*		-40.0 ÷ H03	°C
Pa H05	Number of circuits on machine		0 ÷ 2	Num
Pa H06	Number of *compressors* per circuit		0 ÷ 4	Num
Pa H07	Number of capacity steps per compressor		0 ÷ 3	Num
Pa H08	*Compressors* on sequence		0÷1	Flag
Pa H09	Circuit balancing		0÷1	Flag
Pa H10	Presence of heat pump		0 ÷ 1	Flag
Pa H11	Configuration ST1		0 ÷ 4	Num
Pa H12	Configuration ST2		0 ÷ 3	Num
Pa H13	Configuration ST3		0 ÷ 5	Num
Pa H14	Configuration ST4		0 ÷ 3	Num
Pa H15	Configuration ST5		0 ÷ 5	Num
Pa H16	Configuration ST6		0 ÷ 3	Num
Pa H17	Bottom of scale pressure value		0-350	KPa*10
Pa H18	Polarity ID1 ID2 ID3 ID4		0 ÷ 1	Flag
Pa H19	Polarity ID5 ID6 ID7 ID8		0 ÷ 1	Flag

Pa H20	Polarity ID9 ID10 ID11 ST4		0 ÷ 1	Flag
Pa H21	Polarity ST1		0 ÷ 1	Flag
Pa H22	Polarity ST2		0 ÷ 1	Flag
Pa H23	Configuration ID1		0 ÷ 19	Num
Pa H24	Configuration ID2		0 ÷ 19	Num
Pa H25	Configuration ID3		0 ÷ 19	Num
Pa H26	Configuration ID4		0 ÷ 19	Num
Pa H27	Configuration ID5		0 ÷ 19	Num
Pa H28	Configuration ID6		0 ÷ 19	Num
Pa H29	Configuration ID7		0 ÷ 19	Num
Pa H30	Configuration ID8		0 ÷ 19	Num
Pa H31	Configuration ID9		0 ÷ 19	Num
Pa H32	Configuration ID10		0 ÷ 19	Num
Pa H33	Configuration ID11		0 ÷ 19	Num
Pa H34	Configuration ST4 if digital input		0 ÷ 19	Num
Pa H35	Configuration relay 2		0 ÷ 11	Num
Pa H36	Configuration relay 3		0 ÷ 11	Num
Pa H37	Configuration relay 4		0 ÷ 11	Num
Pa H38	Configuration relay 5		0 ÷ 11	Num
Pa H39	Configuration relay 6		0 ÷ 11	Num
Pa H40	Configuration relay 7		0 ÷ 11	Num
Pa H41	Polarity RL2		0 ÷ 1	Flag
Pa H42	Polarity RL3		0 ÷ 1	Flag
Pa H43	Polarity RL4		0 ÷ 1	Flag
Pa H44	Polarity RL5		0 ÷ 1	Flag
Pa H45	Alarm relay polarity		0 ÷ 1	Flag
Pa H46	Configuration fan 1 output		0 ÷ 1	Flag
Pa H47	Configuration fan 2 output		0 ÷ 2	Num
Pa H48	Free		0 ÷ 1	Flag
Pa H49	*Selection* of operating mode		0 ÷ 1	Flag
Pa H50	Enable *dynamic set point*		0 ÷ 1	Flag
Pa H51	Offset of *dynamic set point* during *cooling*		-12.7 ÷ 12.7	°C
Pa H52	Offset of *dynamic set point* during *heating*		-12.7 ÷ 12.7	°C
Pa H53	Dynamic outdoor temp. *set point* during *cooling*		0 ÷ 255	°C
Pa H54	Dynamic outdoor temp. *set point* during *heating*		0 ÷ 255	°C
Pa H55	Delta dynamic outdoor temp. *set point* during *cooling*		-12.7 ÷ 12.7	°C
Pa H56	Delta dynamic outdoor temp. *set point* during *heating*		-12.7 ÷ 12.7	°C
Pa H57	Offset ST1		-12.7 ÷ 12.7	°C
Pa H58	Offset ST2		-12.7 ÷ 12.7	°C
Pa H59	Offset ST3		-127 ÷ 127	°C/10-Kpa*10
Pa H60	Offset ST4		-12.7 ÷ 12.7	°C
Pa H61	Offset ST5		-12.7 ÷ 12.7	°C
Pa H62	Offset ST6		-127 ÷ 127	°C/10-Kpa*10
Pa H63	0=50 Hz 1=60 Hz		0 ÷ 1	Flag
Pa H64	0= °C 1=°F			Flag
Pa H65	Family serial address		0 ÷ 14	Num.
Pa H66	Device serial address		0 ÷ 14	Num.
Pa H67	User password		0 ÷ 255	Num.
Pa H68	*Copy card* password		0 ÷ 255	Num.

* If *parameters* in this category are modified, the controller must be turned off and on again to ensure correct functioning.

Alarm parameters

ALARM PARAMETERS				
Par.	Description	Value	Limits	Unit of measurement
Pa A01	Low pressure switch bypass time after compressor on		0 ÷ 255	Seconds
Pa A02	Low pressure *alarm events per hour*		0 ÷ 255	Num
Pa A03	Flow switch bypass time after pump on		0 ÷ 255	Seconds
Pa A04	Duration of active flow switch input		0 ÷ 255	Seconds
Pa A05	Duration of inactive flow switch input		0 ÷ 255	Seconds
Pa A06	Number of flow switch *alarm events per hour*		0 ÷ 255	Num
Pa A07	Bypass compressor thermal switch from compressor on		0 ÷ 255	Seconds
Pa A08	Number of *compressors* 1 + 2 thermal switch *alarms*/hour		0 ÷ 255	Num
Pa A09	Number of fan thermal switch alarm events/hour		0 ÷ 255	Num
Pa A10	Anti-freeze alarm bypass after ON-OFF		0 ÷ 255	Minutes
Pa A11	Anti-freeze alarm activation *set point*		-127 ÷ 127	°C
Pa A12	*Hysteresis* of anti-freeze alarm		0 ÷ 25.5	°C
Pa A13	Anti-freeze alarm events/hour		0 ÷ 255	Num
Pa A14	Analogue input high pressure/temperature activation *set point*		0 ÷ 900	°C/10 – Kpa*10
Pa A15	Analogue input high pressure *hysteresis*		0 ÷ 255	°C/10 – Kpa*10
Pa A16	Analogue input low pressure activation bypass		0 ÷ 255	Seconds
Pa A17	Analogue input low pressure activation *set point*		-500 ÷ 800	°C/10 – Kpa*10
Pa A18	Analogue input low pressure *hysteresis*		0 ÷ 255	°C/10 – Kpa*10
Pa A19	Analogue input low pressure *alarm events per hour*		0 ÷ 255	Num

	Pa A20	Machine out of coolant differential		0 ÷ 255	°C
	Pa A21	Machine out of coolant bypass		0 ÷ 255	Minutes
	Pa A22	Machine out of coolant duration		0 ÷ 255	Minutes
	Pa A23	Machine out of coolant alarm triggered		0 ÷ 1	Flag
	Pa A24	Enable low pressure alarm during *defrost*		0 ÷ 1	Flag
	Pa A25	Input over-temperature *set point*		0 ÷ 255	°C
	Pa A26	Input over-temperature duration		0 ÷ 255	S*10
Compressor parameters		*COMPRESSOR PARAMETERS*			
	Par.	Description	Value	Limits	Unit of measurement
	Pa C01	ON-OFF safety time		0 ÷ 255	Seconds*10
	Pa C02	ON-ON safety time		0 ÷ 255	Seconds*10
	Pa C03	*Hysteresis* regulation algorithm during *cooling*		0 ÷ 25.5	°C
	Pa C04	*Hysteresis* regulation algorithm during *heating*		0 ÷ 25.5	°C
	Pa C05	Regulation algorithm step intervention delta			
	Pa C06	Compressor – compressor on interval		0 ÷ 255	Seconds
	Pa C07	Compressor – compressor off interval		0 ÷ 255	Seconds
	Pa C08	Capacity step on interval		0 ÷ 255	Seconds
Fan control parameters		*FAN CONTROL PARAMETERS*			
	Par.	Description	Value	Limits	Unit of measurement
	Pa F01	Fan output mode		0 ÷ 2	Num.
	Pa F02	Fan *pick-up* time		0 ÷ 255	Seconds/10
	Pa F03	Fan *phase shift*		0 ÷ 100	%
	Pa F04	*Impulse duration* of triak on		0 ÷ 255	uS*100
	Pa F05	Functioning in response to compressor request		0 ÷ 1	Flag
	Pa F06	Minimum speed during *cooling*		0 ÷ 100	%
	Pa F07	Maximum silent speed during *cooling*		0 ÷ 100	%
	Pa F08	Minimum fan speed temperature/pressure *set point* during *cooling*		-500 ÷ 800	°C/10 - Kpa*10
	Pa F09	Prop. band during *cooling*		0 ÷ 255	°C/10 - Kpa*10
	Pa F10	Delta *cut-off*		0 ÷ 255	°C/10 - Kpa*10
	Pa F11	*Cut-off hysteresis*.		0 ÷ 255	°C/10 - Kpa*10
	Pa F12	Bypass time *cut-off*		0 ÷ 255	Seconds
	Pa F13	Max speed during *cooling*		0 ÷ 100	%
	Pa F14	Maximum fan speed temperature/pressure *set point* during *cooling*		-500 ÷ 800	°C/10 - Kpa*10
	Pa F15	Minimum speed during *heating*		0 ÷ 100	%
	Pa F16	Maximum silent speed during *heating*		0 ÷ 100	%
	Pa F17	Minimum fan speed temperature/pressure *set point* during *heating*		-500 ÷ 800	°C/10 - Kpa*10
	Pa F18	Prop. band during *heating*		0 ÷ 255	°C/10 - Kpa*10
	Pa F19	Maximum fan speed during *heating*		0 ÷ 100	%
	Pa F20	Maximum fan speed temperature/pressure *set point* during *heating*		-500 ÷ 800	°C/10 - Kpa*10
	Pa F21	Preventilation in *cooling* mode		0 ÷ 255	Seconds
	Pa F22	Combined or separate fan control		0 ÷ 1	Flag
	Pa F23	Fan activation temperature/pressure *set point* during defrosting		-500 ÷ 800	°C/10 - Kpa*10
	Pa F24	Fan activation *hysteresis* during defrosting		0 ÷ 255	°C/10 - Kpa*10
	Pa F25	Preventilation after defrosting		0 ÷ 255	Seconds
Pump parameters		*PUMP PARAMETERS*			
	Par.	Description	Value	Limits	Unit of measurement
	Pa P01	Pump operating mode		0 ÷ 1	Flag
	Pa P02	Delay between pump ON and compressor ON		0 ÷ 255	Seconds
	Pa P03	Delay between compressor OFF and pump OFF		0 ÷ 255	Seconds
Electrical heater parameters		*ELECTRICAL HEATER PARAMETERS*			
	Par.	Description	Value	Limits	Unit of measurement
	Pa r01	Configuration of electrical heaters in *defrost* mode		0 ÷ 1	Flag
	Pa R02	Configuration of electrical heaters on in *cooling* mode		0 ÷ 1	Flag
	Pa r03	Configuration of electrical heaters on in *heating* mode		0 ÷ 1	Flag
	Pa r04	Configuration of electrical heater 1 control probe		0 ÷ 6	Num
	Pa r05	Configuration of electrical heater 2 control probe		0 ÷ 6	Num
	Pa r06	Configuration of electrical heaters when OFF or on *STAND-BY*		0 ÷ 1	Flag
	Pa r07	*Set point* of electrical heater 1 in *heating* mode		Pr09 ÷ Pr10	°C
	Pa r08	*Set point* of electrical heater 1 in *cooling* mode		Pr09 ÷ Pr10	°C
	Pa r09	Max. *set point* electrical heaters		P r10 ÷ 127	°C
	Pa r10	Min. *set point* electrical heaters		-127 ÷ P r09	°C
	Pa r11	*hysteresis* of anti-freeze heaters		0 ÷ 25.5	°C
	Pa R12	*Set point* of external anti-freeze electrical heaters		Pr09 ÷ Pr10	°C
	Pa r13	*Set point* of electrical heater 2 in *heating* mode		Pr09 ÷ Pr10	°C
	Pa r14	*Set point* of electrical heater 2 in *cooling* mode		Pr09 ÷ Pr10	°C

Pa r15	Enable *supplementary electrical heaters*		0 ÷ 1	Flag
Pa r16	Delta of activation of supplementary heater 1		0 ÷ 25.5	°C
Pa r17	Delta of activation of supplementary heater 2		0 ÷ 25.5	°C

Defrost parameters

DEFROST PARAMETERS

Par.	Description	Value	Limits	Unit of measurement
Pa d01	*Defrost* enabled		0 ÷ 1	Flag
Pa d02	*Defrost start* temperature/pressure		-500 ÷ 800	°C/10 - Kpa*10
Pa d03	*Defrost* interval		0 ÷ 255	Minutes
Pa d04	*Defrost end* temperature/pressure		-500 ÷ 800	°C/10 – Kpa*10
Pa d05	Maximum *defrost* time		0 ÷ 255	Minutes
Pa d06	Compressor-*reversing valve* wait time		0 ÷ 255	Seconds
Pa d07	*Drip time*		0 ÷ 255	Seconds
Pa d08	Delay between defrosting of circuits		0 ÷ 255	Seconds*10
Pa d09	Output probe *defrost* circuit 1		0 ÷ 8	Num
Pa d10	Output probe *defrost* circuit 2		0 ÷ 8	Num
Pa d11	Delay in *compressors* on in *defrost* mode		0 ÷ 255	Seconds

Extension parameters

EXTENSION PARAMETERS

Par.	Description	Value	Limits	Unit of measurement
Pa N01	Polarity of ID12 ID13 ID14 ID15		0 ÷ 1	Flag
Pa N02	Configuration ID12		0 ÷ 19	Num
Pa N03	Configuration ID13		0 ÷ 19	Num
Pa N04	Configuration ID14		0 ÷ 19	Num
Pa N05	Configuration ID15		0 ÷ 19	Num
Pa N06	Configuration relay 9		0 ÷ 11	Num
Pa N07	Configuration relay 10		0 ÷ 11	Num

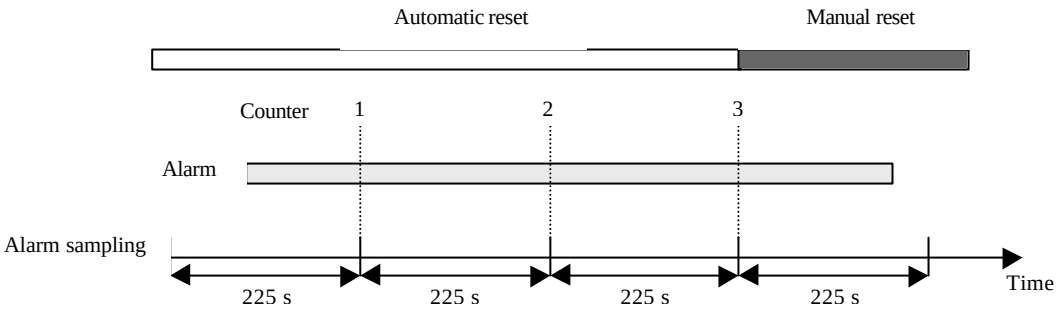
10 DIAGNOSTICS

Alarms

"*Energy 400*" can perform full systems *diagnostics* and signal a series of *alarms*.
Alarm trigger and *reset* modes are set using *parameters Pa A01 – Pa A26*.

Alarm events per hour

For some *alarms* the signal will not be given for a certain amount of time, determined by a parameter.
For some *alarms* the number of alarm events is counted; if the number of alarm events in the past hour exceeds a certain threshold set by a parameter, the alarm will switch from automatic to *manual reset*.
Alarms are sampled every 113 seconds;
Example: if the number of events/hour is set to 3, the duration of an alarm must fall between 2*113 seconds and 3*113 seconds for the alarm to be switched from automatic to *manual reset*.



If an alarm is triggered more than once within one sampling period (113 seconds), only one alarm will be counted.

Alarms with *manual reset* are *reset* by pressing the ON-OFF button and releasing

Manual reset shuts down corresponding *loads* and requires an operator to intervene (*reset* the alarm using the ON-OFF control).
Manual reset alarms are used mainly to identify problems which could result in damage to the system

10.1 List of alarms

When an alarm is triggered, two things occur:
- The corresponding *loads* are shut down
- The alarm appears on the *keyboard display*

The alarm message consists of a code with the format "Enn" (where nn is a 2-digit number identifying the type of alarm, such as: E00, E25, E39....).
All possible *alarms* are listed in the table below, along with their codes and the corresponding *loads* that will be shut down:

Tabella Allarmi

CODE	MESSAGE	DESCRIPTION	*LOADS* SHUT DOWN								
			COMP.1	COMP.2	COMP.3	COMP.4	FAN1	FAN2	PUMP	RES.1	RES.2
E00	Remote off	• All *loads* will be shut down; • Triggered by the digital input configured as "Remote OFF" (refer to *digital inputs*)	YES	YES	YES	YES	YES	YES	YES	YES	YES
E01	High pressure circuit 1	• *Compressors* in circuit 1 will be shut down; • Triggered by the digital input configured as "High pressure circuit 1" (refer to *digital inputs*)	YES	YES1	YES1	YES1					
E02	Low pressure circuit 1	• *Compressors* in circuit 1 will be shut down; also condenser fans if condensation is separate for the 2 circuits (refer to *combined or separate condensation*); • Triggered by the digital input configured as "Low pressure circuit 1" (refer to *digital inputs*); • Automatically *reset* unless *alarm events per hour* reaches the value of parameter *Pa A02*, after which manually *reset*; • Inactive during timer *Pa A01* after compressor on or reversal of 4-way valve (*reversing valve*) in circuit 1	YES	YES1	YES1	YES1	YES	YES[2]			
E03	Thermal switch protection compressor 1	• Compressor 1 will be shut down; • Triggered by the digital input configured as "Thermal switch compressor 1" (refer to *digital inputs*); • Automatically *reset* until *alarm events per hour* reaches the value of parameter *Pa A07*, after which manually *reset*; • Inactive during timer *Pa A08* after compressor on.	YES								
E04	Thermal switch protection condenser fan circuit 1	• Fans and *compressors* in circuit 1 will be shut down; if the 2 circuits are set up for combined condensation, (refer to *combined or separate condensation*) *compressors* in circuit 2 will also be shut down; • Triggered by the digital input configured as "Thermal switch fan circuit 1" (refer to *digital inputs*); • Automatically *reset* until *alarm events per hour* reaches the value of parameter *Pa A09*, after which manually *reset*;	YES	YES1	YES1 - YES[2]	YES1 - YES[2]	YES	YES[2]			
E05	Anti-freeze circuit 1	• Fans and *compressors* in circuit 1 will be shut down; • Active if analogue probe ST2 (refer to *analogue inputs*) is configured as anti-freeze probe (*Pa H12* = 1); • Triggered when probe ST2 detects a value lower than *Pa A11*; • Turned off if probe ST2 detects a value greater than *Pa A11* + *Pa A12*; • Automatically *reset* until *alarm events per hour* reaches the value of parameter *Pa A13*,after which manually *reset*; • Inactive during timer *Pa A10* after *Energy 400* is turned on with the On-OFF key (refer to *keyboard*) or from the digital input ON-OFF (refer to *digital inputs*) or when *heating* mode is started.	YES	YES1	YES1	YES1	YES	YES[2]			
E06	Probe ST2 fault	• All *loads* will be shut down; • Triggered if probe ST2, configured as an analogue input, shorts or is cut off or probe limits are exceeded (-50°C.. 100°C).	YES	YES	YES	YES	YES	YES	YES	YES	YES
E07	Probe ST3 fault	• All *loads* will be shut down; • Triggered if probe ST3, configured as an analogue input, shorts or is cut off or probe limits are exceeded (-50°C.. 100°C).	YES	YES	YES	YES	YES	YES	YES	YES	YES

E08	External circuit 1 anti-freeze	• Fans and *compressors* will be shut down; • Active if analogue probe ST3 (refer to *analogue inputs*) is configured as an external anti-freeze probe (*Pa H13* = 4); • Active when probe ST3 detects a value lower than *Pa A11*; • Goes off if probe ST3 detects a value greater than *Pa A11* + *Pa A12*; • Automatically *reset* until *alarm events per hour* reach the value of parameter *Pa A13*, after which manually *reset*; • Inactive during timer *Pa A10* after *Energy 400* is turned on using the On-OFF key (refer to *keyboard*) or ON-OFF digital input (refer to *digital inputs*) or *heating* mode is switched on.	YES	YES	YES	YES	YES	YES			
E09	High pressure compressor 1	Compressor 1 will be shut down; Triggered by the digital input configured as "High pressure compressor 1" (refer to *digital inputs*); Always manually *reset*	YES								
E13	Thermal switch protection compressor 2	Compressor 2 will be shut down; Triggered by the digital input configured as "Thermal switch compressor 2" (refer to *digital inputs*); Automatically *reset* until *alarm events per hour* reach the value of parameter *Pa A07*, after which manually *reset*; Inactive during timer *Pa A08* after compressor is turned on.		YES							
E19	High pressure compressor 2	Compressor 2 will be shut down; Triggered by the digital input configured as "High pressure compressor 1" (refer to *digital inputs*); Always manually *reset*		YES							
E21	High pressure circuit 2	*Compressors* in circuit 2 will be shut down; Triggered by the digital input configured as "High pressure circuit 2" (refer to *digital inputs*)			YES	YES					
E22	Low pressure circuit 2	*Compressors* in circuit 2 will be shut down, as well as condenser fans if the 2 circuits have separate condensation (refer to *combined or separate condensation*); Triggered by the digital input configured as "Low pressure circuit 2" (refer to *digital inputs*); Automatically *reset* until *alarm events per hour* reaches the value of parameter *Pa A02*, after which manually *reset*; Inactive during timer *Pa A01* after compressor on or reversal of 4-way valve (*reversing valve*) of circuit 1			YES	YES	YES	YES2			
E23	Thermal switch protection compressor 3	Compressor 3 will be shut down; Triggered by the digital input configured as "Thermal switch compressor 3" (refer to *digital inputs*); Automatically *reset* until *alarm events per hour* reach value of parameter *Pa A07*, after which manually *reset*; Inactive during timer *Pa A08* after compressor on.			YES						
E24	Thermal switch protection condenser fan circuit 2	Fans and *compressors* in circuit 2 will be shut down; if the 2 circuits have combined condensation (refer to *combined or separate condensation*) the *compressors* in circuit 1 will also be shut down; Triggered by the digital input configured as "Thermal switch circuit 2 fan" (refer to *digital inputs*); Automatically *reset* until *alarm events per hour* reaches value of parameter *Pa A09*, after which manually *reset*;	YES2	YES2	YES	YES	YES2	YES			
	Anti-freeze circuit 2	Fans and *compressors* will be shut down;			YES	YES	YES2	YES			

		Active if analogue probe ST5 (refer to *analogue inputs*) is configured as anti-freeze probe (*Pa H15* = 1); Triggered when probe ST5 detects a value below *Pa A11*; Turns off when probe ST5 detects a value above *Pa A11* + *Pa A12*; Automatically *reset* until *alarm events per hour* reaches value of parameter *Pa A13*, after which manually *reset*; Inactive during timer *Pa A10* after turning on *Energy 400* using On-OFF key (refer to *keyboard*) or digital input ON-OFF (refer to *digital inputs*) or start of *heating* mode.									
E26	Probe ST5 fault	All *loads* will be shut down; Triggered if probe ST5, configured as an analogue input, shorts or is cut off or probe limits are exceeded (-50°C.. 100°C).	YES	YES	YES	YES	YES	YES	YES	YES	YES
E27	Probe ST6 fault	All *loads* will be shut down; Triggered if probe ST6, configured as an analogue input, shorts or is cut off or probe limits are exceeded (-50°C.. 100°C).	YES	YES	YES	YES	YES	YES	YES	YES	YES
E08	External circuit 2 anti-freeze	• Fans and *compressors* will be shut down; • Active if analogue probe ST6 (refer to *analogue inputs*) is configured as an external anti-freeze probe (*Pa H13* = 4); • Active when probe ST6 detects a value lower than *Pa A11*; • Goes off if probe ST6 detects a value greater than *Pa A11* + *Pa A12*; • Automatically *reset* until *alarm events per hour* reach the value of parameter *Pa A13*, after which manually *reset*; • Inactive during timer *Pa A10* after *Energy 400* is turned on using the On-OFF key (refer to *keyboard*) or ON-OFF digital input (refer to *digital inputs*) or *heating* mode is switched on.	YES	YES	YES	YES	YES	YES			
E29	High pressure compressor 3	Compressor 3 will be shut down; Triggered by the digital input configured as "High pressure compressor 3" (refer to *digital inputs*); Always manually *reset*			YES						
E33	Thermal switch protection compressor 4	Compressor 4 will be shut down; Triggered by the digital input configured as "Thermal switch compressor 4" (refer to *digital inputs*); Automatically *reset* until *alarm events per hour* reaches the value of parameter *Pa A07*, after which manually *reset*; Inactive during timer *Pa A08* after compressor on.				YES					
E39	High pressure compressor 4	Compressor 4 will be shut down; Triggered by the digital input configured as "High pressure compressor 4" (refer to *digital inputs*); Always manually *reset*				YES					
E40	Probe ST1 fault	All *loads* will be shut down; Triggered if probe ST1, configured as an analogue input, shorts or is cut off or probe limits are exceeded (-50°C.. 100°C).	YES	YES	YES	YES	YES	YES	YES	YES	YES
E41	Flow switch	All *compressors*, fans and pump will be cut off if manually *reset*; Triggered if the digital input configured as "Flow switch" (refer to *digital inputs*) remains active for an amount of time equal to *Pa A04*; Goes off if the digital input configured as "Flow switch" (refer to *digital inputs*) remains inactive for an amount of time equal to *Pa A05*;	YES	YES	YES	YES	YES	YES	SI[3]		

		Automatically *reset* until *alarm events per hour* reaches the value of parameter *Pa A06* , after which manually *reset*; Inactive during timer *Pa A03* following pump on.									
E42	Probe ST4 fault	All *loads* will be shut down; Triggered if probe ST4, configured as an analogue input, shorts, is cut off, or probe limits are exceeded (-50°C.. 100°C).	YES	YES	YES	YES	YES	YES	YES	YES	YES
E45	Configuration error	All *loads* will be shut down; Triggered if at least one of the following conditions apply: H11= 2 (ST1 configured as request for *heating*), H12= 2 (ST2 configured as request for *cooling*) and both inputs are active. Sum of *compressors* and capacity steps on machine exceeds 4 The *keyboard* is declared present (Pa H69=1) and there is no communication between the *keyboard* and the basic unit.	YES	YES	YES	YES	YES	YES	YES	YES	YES
E46		All *loads* will be shut down except the pump; Triggered if probe ST1 (refer to *analogue inputs*) has a value exceeding *Pa A25* for an amount of time exceeding Pa 26 in *cooling* mode; Goes off if probe ST1 (refer to *analogue inputs*) has a value lower than *Pa A25* – *Pa A12*; Automatically *reset*.	YES	YES	YES	YES	YES	YES		YES	YES

[1] If it belongs to circuit 1
[2] If combined condensation system
[3] Only if *manual reset* e

outputs defined as capacity steps will go off if there is an alarm for the compressor to which they belong

The tables below list *alarms* by type (digital or analogue).

Digital alarms

TABLE OF *DIGITAL ALARMS*:

Alarm name	Bypass trigger event	Bypass time	Trigger duration	Deactivation duration	N. alarm events/hour
Compressor 1,2,3,4 high pressure alarm	None	absent	absent	absent	*Manual reset*
High pressure circuit alarm	None	absent	absent	absent	*Manual reset*
Low pressure alarm	A compressor coming on in the circuit or reversal of 4-way valve	*Pa A01*	absent	absent	*Pa A02*
Flow switch alarm	Pump coming on	*Pa A03*	*Pa A04*	*Pa A05*	*Pa A06*
Compressor 1,2,3,4 thermal switch alarm	Compressor coming on	*Pa A07*	absent	absent	*Pa A08*
Fan 1,2 thermal switch alarm	None	absent	absent	absent	*Pa A09*

TABLE OF *ANALOGUE ALARMS*:

Analogue alarms

Alarm name	Event	Bypass time	Trigger *set point*	*Hysteresis*	N. alarm events/hour	Regulation probe
Anti-freeze alarm circuit 1	On Off, input in *heating* mode, remote on off	*Pa A10*	*Pa A11*	*Pa A12* positive	*Pa A13*	ST2 if configuration parameter *Pa H12* = 1, otherwise alarm is inactive
Anti-freeze alarm circuit 2	On Off, input in *heating* mode, remote on off	*Pa A10*	*Pa A11*	*Pa A12* positive	*Pa A13*	ST5 if configuration parameter *Pa H15* = 1, otherwise alarm is inactive
External anti-freeze alarm circuit 1	On Off, input in *heating* mode, remote on off	*Pa A10*	*Pa A11*	*Pa A12* positive	*Pa A13*	ST3 if configuration parameter *Pa H13* = 4, otherwise alarm is inactive
External anti-freeze alarm circuit 2	On Off, input in *heating* mode, remote on off	*Pa A10*	*Pa A11*	*Pa A12* positive	*Pa A13*	ST6 if configuration parameter *Pa H16* = 4, otherwise alarm is inactive
Low pressure /low temperature condensation alarm circuit 1	Compressor turned on or reversal of 4-way valve	Par A16	*Pa A17*	*Pa A18* positive	*Pa A19*	ST3 se *Pa H13*=1 or 2 or else ST4 if *Pa H14* = 1, otherwise alarm is inactive
Low pressure /low temperature condensation alarm circuit 2	Compressor turned on or reversal of 4-3way valve	Par A16	*Pa A17*	*Pa A18* positive	*Pa A19*	ST6 if *Pa H16*=1, otherwise alarm is inactive
High pressure /high temperature condensation alarm circuit 1	None	absent	*Pa A14*	*Pa A15* negative	*Manual reset*	ST3 if *Pa H13*=1 or 2, or ST4 if *Pa H14* = 1; otherwise alarm is inactive
High pressure /high temperature condensation alarm circuit 2	None	absent	*Pa A14*	*Pa A15* negative	*Manual reset*	ST6 if *Pa H16*=1 or 2, otherwise alarm is inactive
High temperature regulation algorithm alarm*	None	absent	*Pa A25*	*Pa A12* negative	Automatic *reset*	ST1

11 TECHNICAL FEATURES

11.1 Technical data

	Typical	Min.	Max.
Power supply voltage	12V~	10V~	14V~
Power supply frequency	50Hz/60Hz	---	---
Power	5VA	---	---
Insulation class	1	---	---
Protection grade	Front panel IP0	---	---
Operating temperature	25°C	0°C	60°C
Operating humidity (non-condensing)	30%	10%	90%
Storage temperature	25°C	-20°C	85°C
Storage humidity (non-condensing)	30%	10%	90%

11.2 Electromechanical features

110/230 V digital *outputs*	n° 8 5 A resistive relays; ¼ hp 230VAC; 1/8 hp 125VAC
Analogue *outputs*	n° 2 triac piloting *outputs* or configurable 4-20 mA *outputs* n° 1 4-20 mA output
Analogue inputs	n° 4 NTC R_{25} 10KΩ N° 2 configurable input or 4-20mA o r NTC R_{25} 10KΩ
Digital inputs	n° 11 voltage-free *digital inputs* 10m A
Terminals and connectors	n° 1 10-way high voltage connectors, step 7.5 n° 2 16-way rapid clamp connectors for low voltage, step 4.2, AWG 16-28 n° 1 p2.5 5–way connector for remote control and programming with external *copy card*, AWG 24-30 n° 1 20-way connector for connection of *extension* n° 1 3-way screw terminal for *remote keyboard*
Serial ports	n° 1 9600 serial port n° 1 2400 serial port

current transformer

The instrument must be powered with a suitable *current transformer* with the following features:

- Primary voltage: 230V~-15%÷+6%; 110V~±10%
- Secondary voltage: 12V~
- Power supply frequency: 50Hz; 60Hz
- Power: 5VA;

11.3 Regulations

The product complies with the following European Community Directives:

- **Council Directive 73/23/CEE and subsequent modifications**
- **Council directive 89/336/CEE and subsequent modifications**

and complies with the following harmonised *regulations*:

- **LOW VOLTAGE: EN60730**
- **EMISSION: EN50081-1 (EN55022)**
- **IMMUNITY: EN50082-1 (IEC 801-2,3,4)**

12 USE OF THE DEVICE

12.1 Permitted use

This product is used to control single and dual circuit chillers and heat pumps.

To ensure safety, the controller must be installed and operated in accordance with the instructions supplied, and access to high voltage *components* must be prevented under regular operating conditions. The device shall be properly protected against water and dust and shall be accessible by using a tool only. The device is suitable for incorporation in a household appliance and/or similar air conditioning device.
According to the reference *regulations*, it is classified:

- In terms of construction, as an automatic electronic control device to be incorporated with independent assembly or integrated;
- In terms of automatic operating features, as a type 1 action control device, with reference to manufacturing tolerances and drifts;
- As a class 2 device in relation to protection against electrical shock;
- As a class A device in relation to software structure and class.

12.2 Forbidden use

Any use other than the *permitted use* is forbidden.
Please note that relay contacts supplied are functional and are subject to fault (in that they are controlled by an electronic component and be shorted or remain open); protection devices recommended by product standards or suggested by common sense in response to evident safety requirements shall be implemented outside of the instrument.

13 RESPONSIBILITY AND RESIDUAL RISKS

Microtech shall not be held liable for any damage incurred as a result of:

- *installation*/use other than those intended, and, in particular, failure to comply with the safety instructions specified by applicable *regulations* and/or provided in this document;
- use with equipment which does not provide adequate protection against electric shocks, water and dust under the effective conditions of *installation*;
- use with equipment which permits access to hazardous parts without the use of tools;
- *installation*/use with equipment which does not comply with current *regulations* and legislation.

14 GLOSSARY

OR logico
Multiple inputs with an OR relationship to one another are equivalent to a single input with the following status:
- Active if at least one input is active
- Inactive if no input is active

Scroll up
To "*Scroll up*" a menu means listing the various *parameters* from the bottom up (Pa10 -> Pa 09 -> Pa 08 ....)

Stand-by
Indicates that the instrument is waiting, in *stand-by* mode; all *functions* are suspended.

Reset
Set to zero.

Reset alarm
Resetting an alarm means reactivating it ready for a new signal.

Manual reset
A *manual reset alarm* must be *reset* using the *keyboard*.

Scroll down
To "*Scroll down*" in a menu is to list *parameters* from the top down (Pa08 -> Pa 09 -> Pa 10 ....)

BLINK
Means flashing; normally refers to leds

Average number of hours
Average number of hours is the ratio between the total number of hours for which the *compressors* are available and the number of *compressors* in the circuit

Loads
Devices in the system, including *compressors*, fans, *hydraulic pump*, electrical anti-freeze heaters...

Set Point
A reference value (set by the user) defining the system's operating status, such as the thermostat that controls temperature in the home: if we want to maintain a temperature of 20 °C we set the *set point* to 20°C (the *heating* system will come on if the temperature in the house falls below 20°C, and go off if it exceeds this value).

Range
Values falling within a given interval; *Range* 1...100 indicates all values between 1 and 100

Hysteresis
A *hysteresis* is normally defined around a *set point* to prevent frequent oscillation of the change of status of the load being controlled;
Example: suppose we have a *set point* of 20 °C on a probe for measurement of room temperature, above which a compressor will be started up;
When room temperature nears the *set point* (20 °C) there will be an unstable phase during which the relay which starts up the compressor will frequently switch from ON to OFF and vice versa, which could result in serious damage to the system.
To prevent this problem a *hysteresis* is defined: an interval of tolerance within which there will be no change in status; in our example, we could set a *hysteresis* of 1 °C, in which case the compressor would be started up at 21 °C (*set point* + *hysteresis*) and turned off at 19 °C (*set point* – *hysteresis*)

Permanent memory
Memory in which data is maintained even when the device is turned off (as distinct from temporary memory, the data in which is lost when the device is turned off.)

Cut-off
Temperature/pressure below or above which proportional output is cut off.

15 ANALITIC INDEX

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